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Communication Research on Sign Language Telecommunication and Digital Modes of Interpretation.

Scooter Briody
Western Michigan University

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A NARRATIVE REVIEW OF THE HISTORY OF DEAF TELECOMMUNICATIONS TECHNOLOGY

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By

Sofia (Scooter) L. Briody

Abstract

Since the invention and proliferation of the telephone in the late nineteenth century, our world has become increasingly dependent on technologically mediated communication. Nowadays we are just as likely to have our next human interaction through our smartphone or computer screen as we are to meet another person face to face. We do not even tend to think of these things as tools for telecommunication anymore, but rather as extensions of our own will. Despite the overwhelming convenience of this technology, it is also fundamentally created with the interests of certain people in mind. If you are able to use a piece of telecommunications technology without significant hindrance, chances are you are without any physical differences, and in relation to the topic of this thesis specifically, you are probably hearing.

The increased reliance on telephony throughout the nineteenth and twentieth centuries marked a period of technological isolation for the Deaf community, a community that was already very societally isolated due to ostracization. The intervening century was spent by many Deaf people on attempting to make up this gap in technology, with little to no help from the telecommunications industry at large. Some pieces of technology that have been the most vital in making up for the lack of active Deaf accommodation from large companies have been the teletypewriter, the video relay service, and the internet. Throughout this paper, we will look at how Deaf people have put in the effort to adapt these pieces of technology for their own use, and the ways in which hearing culture at large has both helped and hindered this journey.

When a piece of Deaf telecommunications technology experiences some degree of success, it is usually due to one or both of the following factors; an immense level of struggle and accomplishment on the part of some very tenacious members of the Deaf community, and the passing interest of hearing culture in the technology on the basis of novelty.

The teletypewriter, which has a level of utility for Deaf people that is not apparent to most hearing people (as we will explore in further detail later), took decades to be distributed to the people who needed it. Videoconferencing, on the other hand, is a technology the utility of which is widely understood, so it was not nearly as difficult for Deaf people to get access to it. The tension between the Deaf community and the technology they use is especially apparent in the relationship between Deaf culture and social media, which challenges Deaf people to decide how strongly they want to present their identity to others. In modern day, the relentless globalization of the internet provides countless new avenues for the building of Deaf community as well as many opportunities for Deaf culture as it has existed in the past to become lost.

Introduction

One of the most long-standing pieces of common wisdom in the field of Communication Studies is "the medium is the message," originally coined by theorist Marshall McLuhan in his 1964 book *Understanding Media: The Extensions of Man*. McLuhan argued that all forms of communication are twofold; the overt content being revealed on the surface and the character of the interaction which affects how we perceive it in innumerable unconscious ways. By studying communication, we make ourselves aware of these nuances, allowing us to better interact with the world, especially with the increasing number of communication mediums that exist every day. Telecommunications, characterized by instant messaging over a remote distance, is a field in which the involvement of the medium is especially obvious. When we are not face to face with someone and yet communicating with them instantaneously, the medium often supplies us with countless avenues for misinterpretation.

Sign Language is a type of communication which is particularly reliant on context. Many of the aspects of communication a hearing layperson might consider peripheral are put front and center when signing; our expressions, our movements, and our bodily positions are all in the spotlight. These essential aspects of Sign Language communication often complicate the access of the Deaf community to proper telecommunications technology. The focus on technology that favors the abilities of hearing people has a long and storied history which can teach us not only about the treatment of the Deaf community but about the general societal perception of visual modes of telecommunication.

Methodology

The research process included searching through the resources available through the Western Michigan University Library website and for free through Google Scholar. Search terms used: "Deaf Telecommunication", "DEAFNET", "Teletypewriter", "Sign Language" +

"Artificial Intelligence", "Signing Virtual Reality", and "Virtual Sign Language Interpreting". The author read and synthesized various sources on these topics in order to create a narrative-based review of the history of Deaf telecommunication. Because of the narrative style of this literature review, the author acknowledges that the information and sources presented here are non-comprehensive.

Narrative Review of Deaf Telecommunications Technology

This paper is organized into three sections, focused on documenting a chronological narrative of the creation of Deaf and Sign Language technology from the advent of telephony to today. The section immediately following this one covers the nineteenth and twentieth centuries and is concerned mainly with how the Deaf community in America dealt with the popularity of the telephone, and with early internet technology. This first section will lay down the historical context for the following section, which documents technologies that emerged beginning in the late twentieth century and into the twenty-first century. These current-day technologies include videoconferencing, video relay services, smart phones, and social media. The third section will cover technologies which show promise for Deaf accommodation, but whose place in Deaf culture is not yet decided because of things like technological shortcomings in representing Sign and lack of affordability. At the end of this review, we will have a better understanding of the ways Deaf telecommunications has developed over the decades in relation to its perception within society.

Looking Back: Deaf Telecommunication in the Nineteenth and Twentieth Century

The following section is dedicated to one header covering the history of the Teletypewriter within American Deaf culture, and another regarding one of the earliest efforts in accommodating Deaf people through the internet, called DEAFNET. The Teletypewriter is often regarded as the Deaf equivalent of the telephone, and its integration into the Deaf community

allowed for a level of independence which had been withheld for almost a century. DEAFNET, on the other hand, has more or less been forgotten within the history of Deaf culture but provides an important example of the Deaf community seizing on a new piece of technology long before most hearing people were aware of its utility.

The Teletypewriter

The invention of the telephone, while groundbreaking, was from the very beginning a tool for the exclusion of the Deaf from wider society (intentionally or not). The reliance on oral communication which came with the proliferation of the telephone meant that any Deaf person who wanted to interact by phone was required to rely on a hearing family member, friend, or neighbor for support. As this new piece of technology became more and more integral to life in our modern world, the independence of Deaf people in relation to telecommunication became all the more limited. As one Deaf person was quoted as saying in the 2000 book A Phone of Our Own; “when someone with normal hearing is not at home, no one is as far as telephone calls are concerned” (Lang, 2000, p.2). It was common for a Deaf person to be forced to waste time and money on completing tasks that would be immensely simple for a hearing person by telephone. For nine decades the Deaf community had to stand by and watch as telephone technology accelerated, and while many different alternatives to the telephone were proposed during that time there was not any apparent movement toward commercially available accommodations.

Many Deaf people found their own individual path toward long-distance communication in this period of technological deficit; as always, the exclusion of hearing culture forced them towards additional effort and technical ingenuity. The oral requirements of the telephone could be accommodated through additions that translated simple phrases to visuals (Lang, 2000), or circumvented by a radio teletypewriter. However, these pieces of tech usually required licensing and a good deal of technical savvy. This made it difficult to build anything but a small

community of committed Deaf people around each of these pieces of tech, creating even more insular groups among an already small minority of Americans.

There is an unfortunate irony in the fact that the ninety-year wait for consumer Deaf telecommunications technology was not actually due to a lack of technology. Around the same time, Alexander Graham Bell was developing the patent for the telephone, he was also working on a related piece of technology that would use gas fires to "render visible to the eye of the deaf the vibrations of the air." (Lang, 2000, p.22) As the son of a Deaf woman and a speech therapist (later also himself marrying a Deaf woman) Bell had a charged relationship with the Deaf community throughout his life. Following in his father's footsteps, Bell was dedicated to the instruction of oralism, an ideology focused critically on making speech understandable to those without hearing.

Oralism is a polarizing attitude in relation to the deaf and hard-of-hearing community because it encourages a reliance on lipreading and learning speech in order for deaf people to assimilate into hearing society rather than developing their own methods of communication. This would often lead to language deprivation in Deaf children instructed under oralism due to being withheld from learning a language that would fully accommodate their communication needs. To Bell, the ability to teach the Deaf to speak and comprehend speech was a point of pride, and visual modes of communication would only get in the way (Lang, 2000).

Bell's professional rival on the other hand, a man named Elisha Gray, also developed his own visual mode of telecommunication. Gray, who submitted a patent for the telephone just hours after Bell submitted his on the same day in 1876 (Karwatka, 2008), went on to later create a piece of technology nearly ideal for use by deaf people. Gray's teleautograph, introduced at the 1893 World's Fair, was capable of recreating written messages by pen almost instantaneously. Messages written on a machine in one location would be repeated on the other machine in

another location by replicating the pen's vibrations (as a result this machine was limited to only communicating in one direction) His invention was a sensation for the American Deaf community at the time, seeming a comparable substitute for the telephones which had already begun to show their potential to push Deaf people even further into the margins of society (Lang, 2000).

However, by then the damage to the telecommunications industry had been done; Graham Bell was already well on his way to going down in history as the inventor of the telephone, and he was bringing his affinity for oralism along with him. There is no telling how much further ahead the field of Deaf telecommunication might be today if it were not for Bell's dogged focus on speech, precluding all other forms of visual telecommunication. Since the world of hearing corporations does not usually perceive Deaf people as being a profitable group, this lack of accommodation continued long after Bell had died. Then in the 1960s, the convergence of developing technology and Deaf ingenuity gave way to an important new development: The Telecommunications Device for the Deaf, by way of the Teletypewriter.

The Teletypewriter, Teleprinter, or TTY was a device that had already existed for decades. A technological descendant of Gray's teleautograph, the TTY is a large, clunky piece of technology that uses radio waves to transmit text instead of words across long distances. Before it was adopted by the Deaf community, it was mainly used by the military and by civilians with a license to operate one (Lang, 2000). Modern TTYs display messages on a scrolling digital screen, whereas the original style of TTY printed its messages out onto spools of paper. These original TTYs were only compatible with others of their kind, and due to the nature of their radio-transmitted messages, they could not transmit and receive at the same time, making interruptions common if message discipline was not adhered to. Some TTYs only had the ability to receive messages, limiting their usefulness even further. Despite the aspects that might have

made it seem as though the TTY was already becoming outdated by the time of the early sixties, the potential of a visual mode of telecommunication was too promising to pass up for a group that had so long been deprived of the level of communication the rest of the world enjoyed.

The plan to make TTYs widely available to the Deaf and hard-of-hearing people of America was developed based on the partnership of three men; Deaf physicist Robert Weitbrecht, Deaf orthodontist Dr. James Marsters, and Deaf engineer Andrew Saks. Weitbrecht was born Deaf whereas Marsters and Saks experienced hearing loss due to illnesses later in life, and all three of them had spent time finding ways to circumvent the lack of commercially available telephone accommodations (Lang, 2000). Weitbrecht had gotten his ham radio license at fifteenand was able to accommodate his lifelong deafness by communicating through Morse code and teletypewriter. Marsters fought with the telephone company to be allowed to utilize a piece of technology called the Listening Head; “a device which allowed him to speak into the telephone as he read the lips of a hearing person who was repeating the voiced message to him” (Lang, 2000, p.15). Saks experimented with numerous devices over the years, mainly light-based signalers of the kind that are now commonly used as fire alarms or baby monitors for the deaf and hard of hearing.

All three of them had been driven by their disabilities towards various levels of technological ingenuity throughout their lives, creating a passion in them for finding new ways to connect Deaf people. They understood the frustrations of the average Deaf person, without access to the resources for circumventing the limits of the telephone, whose daily life was made immensely more complicated by this obstacle.

In 1964, these three men set out to find a way to make TTYs widely available as a Deaf alternative to the telephone. They certainly had their work cut out for them, for a few reasons. Firstly, there was the technological requirement of making the already outdated TTY actually

usable in this capacity. This task was up to Weitbrecht and his radio expertise, who set out to create a modem that would adapt the TTY for more convenient use by allowing its messages to be sent and converted using telephone signals. Secondly was perhaps the even greater roadblock; the reticence of the telephone industry to allow for the accommodation the men wanted to enact.

Not only had the industry been passively choosing to not improve on the Deaf experience of telecommunication, but they were also actively against any modification to the current system. The company which had originally been created out of Alexander Graham Bell's passion for oralism, AT&T, would prove to be the greatest adversary against Weitbrecht and his partners over the years due to their staunch dislike of any outside modification of their telephone system. Weitbrecht was aware that telephone companies were prone to completely destroying TTYs that had fallen out of use in order to prevent them from being stolen; these companies were so protective of their technology that they would rather destroy property than allow the TTYs to be used by needful Deaf people (Lang, 2000).

Weitbrecht also saw resistance from the Alexander Graham Bell Association, some of the members of which saw the TTY as counterintuitive to their encouragement of oralism. After meeting with the association, he recounted that "Certain people object in the way that it does not measure to [the association's] ideals of promotion of lipreading, speechreading and utilization of the residual hearing of the deaf." (Lang, 2000, p.41) In the face of an industry that so unabashedly valued profit over accommodation getting those accommodations actualized was a massive task, but it was one these men knew they needed to undertake despite the obstacles.

Having grown fatigued with waiting for AT&T to move towards making TTYs easily available to the Deaf, Weitbrecht, Marsters, and Saks began a partnership that became the Applied Communications Corporation (APCOM), incorporated in 1965 (Lang, 2000, p.72). The start-up began from a Menlo Park office to finally create a small network of deaf TTY users, and

get the word out further about their services. While there was a lot resting now on one tiny company, the letters the men received from customers excited to finally have their own mode of telecommunication let them know that they were heading in the right direction.

In 1968, as the demand for and awareness of TTYs in the Deaf community continued to grow, the Alexander Graham Bell Association of the Deaf and the National Association of the Deaf formed the Teletypewriters for the Deaf Distribution Committee. Later that same year, the Committee was incorporated, becoming Teletypewriters for the Deaf, Inc. (TDI) (Lang, 2000). The purpose of TDI was to collect and distribute TTYs in accordance with guidelines laid out by AT&T. The two Associations that had come together to create TDI were still divided along the decades-old divide of manualism (Sign Language) vs oralism, but they were unified under the shared effort to distribute TTYs since the use of written English circumvented the argument entirely. While the movement continued to increase the awareness and affordability of TTYs within the Deaf community, across the country Deaf individuals were rejoicing at finally (after almost a century) having access to their own mode of telecommunication.

In 1970, after a long fight on the fronts of both technology and ableism, Weitbrecht patented his modem, and was also nominated as Outstanding Handicapped American of the Year for the year previous (Lang, 2000). However, he and his collaborators still faced pushback from the AT&T company on their ability to fully integrate the use of TTYs for the Deaf. In the early years of TTY distribution, Weitbrecht was inundated with horror stories from customers about faulty machines or telephone workers who did not know how to properly handle the TTY. Once again protective of their own patents, AT&T was still reluctant to accept the TTY, favoring instead their own more impractical advancements. They had developed their own modem and were working on a rudimentary teleconferencing machine called the Picturephone which would not be available on the market for years. For decades their motto had been “One Policy, One

System, Universal Service." (Lang, 2000) They were invested in keeping their customers fully dependent on paying for their systems and subscriptions, an attitude at odds with their inability to provide easily accessible accommodations for their Deaf and hard of hearing customers.

To consolidate these two at-odds forces, Marsters and Weitbrecht advocated for years for AT&T to simply purchase TDI and APCOM. AT&T was as reticent as ever, though, and their pleading was met with little response. Some people thought that the government should take over the distribution of TTYs, but it was a point of pride that Teletypewriters for the Deaf, inc. was created both by and for the Deaf community (Lang, 2000). They could not be sure that any other agency would be able to take over their efforts and still address them with the amount of weight they required. Ultimately the fact that TDI remained independent, while not always a financially advantageous decision, did end up being a powerful one. That the industry was still largely in the hands of Deaf people trying to help other Deaf people was important, even if it meant the movement sometimes struggled to have its concerns acknowledged by larger establishments.

Over the course of the following two decades, the proliferation of TTYs across the Deaf communities of America continued to boom. By 1975 ten thousand TTYs were in use, and the first cross-Atlantic TTY call was made between London and the US with Weitbrecht in attendance (Lang, 2000). By the next year that number had gone up to twenty thousand. The success of TTY distribution had a cyclical effect on the Deaf community; as awareness grew of the ways in which they were oppressed, the desire for appropriate communication methods also grew, and likewise< this increased peoples' ability to build community and political awareness.

In 1988, TTYs played an important part in the "Deaf President Now!" movement at Gallaudet University. The University, which had had only hearing presidents since its founding in 1864 despite being established specifically for the education of the Deaf and hard of hearing, had elected yet another hearing (not to mention non-signing) president. The new president,

Elisabeth Zinser, had been chosen despite considerable rallying around multiple Deaf candidates. Fed up with the lack of representation, the students at Gallaudet barricaded the school and ceased all of its operations for a week until Zinser resigned and the board agreed to the protester's demands, appointing Dr. I King Jordan to the position instead. While far from the first example of Deaf activism, Deaf President Now marked a turning point in the minds of many disability advocates due to the level of publicity it received (Heller et al, 2019). Because most of the people reporting on the protests or watching the events on the news did not know Sign Language, the TTYs on Gallaudet's campus provided a valuable line for the students to use to communicate their demands (Lang, 2000).

In 1934, the US Government passed the Communications Act, which established the FCC with the express goal of providing telecommunication services "so far as possible to all the people of the United States." (Lang, 2000, p. 58) Despite the existence of multiple types of Deaf telecommunication devices both before and after this mandate was put into place, the government did not actually fulfill its promise until 1982 when Congress would finally pass a Telecommunications Act officially including services for disabled people in the mandate. This was followed by the passing of the ADA in 1990, which had federal standards for TTY relay services amended to it a year after that (Lang, 2000).

For decades, Deaf and hard of hearing people were not afforded the same respect as their fellow US citizens and had their ability to communicate technologically withheld, with no reasoning behind it except reticence to put in the effort necessary to help the Deaf community. It was the efforts of people from within the community, motivated by their own annoyance at the shortcomings of technology, which eventually afforded American Deaf people the same telecommunications access as their hearing counterparts.

DEAFNET

At the same time Weibrecht, Marsters, Saks, and the rest of their collaborators were working on making TTYs accessible to the Deaf community, the internet was also beginning to form as a powerful tool for connecting individuals across the world. Deaf people, after decades of having their communication held back by the socially ingrained dependence on the telephone, immediately recognized the incredible potential of the internet and attempted to seize on it. Thus DEAFNET was born, an offshoot of ARPANET, one of the earliest computer networks ever invented (Middleton, 1983).

As stated in one of its original proposals, DEAFNET began at the Stanford Research Institute with the "...concept of a network of deaf persons who have a special communications need and who can now interact with each other (and with hearing persons) to share information, experiences, and learning and to conduct business." (Middleton, 1983, p.614) The creators of the DEAFNET initiative (led by program manager Teresa Middleton) sought to provide the same rudimentary online services that were available through the internet at the time such as e-mail and messaging boards, but tailor the experience to the Deaf community in the twenty largest metropolitan areas in America at the time.

With the congruent development of the internet and Telecommunication Devices for the Deaf, the World Wide Web threatened to end the use of TTYs within the Deaf community right after it had begun due to the fact that they ran on a different type of code than the American Standard for Information Interchange (ASCII) code most computers were using at the time. TTYs, which predated ASCII code, ran instead on a predecessor called Baudot code (the same kind that the telegraph had run off of) (Jensema, 1994). However, an initiative by the US Department of Education in 1978 led to the creation of a system that would allow TDDs to interface with ASCII terminals (Middleton, 1983).

DEAFNET, while a relatively forward-thinking idea at the time of its conception, was also quickly outpaced by the exponential growth of the internet. Once the world wide web was larger than what could be contained by a few regional message boards, there was not as much need for an initiative like DEAFNET. As the accessibility of the internet became more widespread, both to Deaf and hearing people, a system as localized as DEAFNET seemed more and more outdated. That same original proposal from 1983 stated; "...the success of DEAFNET will depend on two factors. First, it must be fully adopted by deaf persons themselves...[second] although purely local networks can be put into place, deaf people in local communities should plan nationally." (p.617) These two requirements unfortunately foreshadowed the reasons why DEAFNET was ultimately not as successful as intended.

DEAFNET was, like so many other pieces of technology, an admirable testament to the ingenuity of the Deaf community when an opportunity arises to seize on a piece of technology that will make the lives of Deaf and hard of hearing people easier. Although the system itself is a thing of the past, DEAFNET was still a groundbreaking initiative that in part paved the way for e-mail and messaging as we know it now (SRI International, 2020). The way that DEAFNET failed to live up to the expectations of its creators could also be seen as foreshadowing the later struggles between the Deaf community and the internet, particularly the way Deaf culture can be flattened when filtered through online communication. What was originally an initiative geared specifically towards the Deaf community later simply melted into the swell of other technological advancements happening at the time, and the mission of an online community for Deaf people fell by the wayside.

The startlingly quick development of the internet also threatened the use of TTYs at the time of DEAFNET, however, TTYs are much further ingrained into the history and culture of Deaf people in America, developing their own connotations and distinct dialects. In this way, the

TTY was successfully "adopted by Deaf persons themselves" (Middleton, 1983, p.617) in a way DEAFNET never was. Today, we can only speculate on how the development of online Deaf communities would have changed if DEAFNET had been more successful, and there had been a specific space on the internet for the purpose of Deaf networking from such an early point in its history.

Current Day Technology: Deaf Telecommunication in the 21st Century

This section, focused on technology which emerged mainly in the late twentieth and twenty-first century, covers some of the pieces of Deaf telecommunication accommodation which are most commonly known today. These include videoconferencing, smart phones, and social media. This section touches most heavily on the intersection between Deaf and hearing technology, and the way that the attitudes of hearing people play into the accessibility of these accommodations.

Videoconferencing and the Video Relay Service

Although it was seen as a novel concept relegated to the world of science by the hearing community for quite a long time, video teleconferencing was always considered a major, tangible goal in the field of Deaf accommodation technology for obvious reasons. From around the time of Alexander Graham Bell and Elisha Gray and onwards, people have been trying to create ways in which we might be able to instantly send a moving image across a distance, allowing two geographically separate people to communicate face to face. Technology such as that created by Bell which attempted to visualize auditory vibrations through the movement of gas flames could be seen as a precursor to this (Lang, 2000). Later on, AT&T did attempt to garner excitement for a "Picturephone" shown by the company at the 1964 World's Fair, but a lack of demand for a technology that was still very expensive to the average person at the time killed any progress for at least three more decades (Lang, 2000).

While the TTY was a huge step forward, it still required its users to communicate in English (or at least, a grammatical combination of English and ASL (Mozzer-Mather, 2002)). It was also seen as very impersonal by people who were used to signing face-to-face, due to the confinement both to English and to written messages (Fitzgerald, 2003). A teleconferencing service, on the other hand, could allow people to communicate using Sign with a level of freedom which finally seemed equivalent to what hearing people had already been experiencing for the past century in relation to the telephone. As a result, videoconferencing services are often rated as more effective by Deaf users than the TTY, both because of their similarities to face-to-face communication and because of their speed (since TTYs can only either transmit or receive a message at any given moment they notoriously take much longer) (Vincent et al, 2010).

In the early days of the internet, TTYs did have an advantage over video teleconferencing due to the huge amount of effort that had already been put into allowing TTYs to operate over normal telephone lines. Even as the Deaf community was exploring the usefulness of the internet through initiatives like DEAFNET, our ability to pass images through it was still very underdeveloped. It was years before getting a video to load at more than one frame per minute was even a possibility (Middleton, 1983).

However, as the internet developed at an alarming rate, this dynamic began to switch. Once the widespread use of fiber optic cables led to levels of internet speed previously unheard of (Jensema, 1994), the development of internet video chatting followed quickly behind. The fact that the proliferation of videoconferencing technology throughout society progressed so much faster than the efforts to distribute TTYs was almost certainly due to the interest of the hearing population. While the utility of a TTY was low for the average hearing person, we have established that most hearing people could quickly grasp the possible usefulness of video

chatting. However, as with anything, the access of Deaf people to this technology is still not as straightforward as it should be.

While the dependence on videoconferencing is seen as a relatively recent development within hearing culture, the usage of such technology in the Deaf community goes back as far as the nineties in some places. In Texas, Dr. Ed Bosson was experimenting with trials for Video Relay Services for the Deaf in 1995, and the government of Sweden established state-mandated VRS for its Deaf citizens as early as 1997, around six years before those services were established by the FCC in America. The most common example in the United States would be the Sorenson Videophone, released by Sorenson Media Inc. in 2003 (Rochester Institute of Technology (RIT), 2024).

Nowadays, if a Deaf person wants to sign with another signing person, they can simply call them using their teleconferencing application of choice and sign with them over their phone or computer just as a hearing person would make a phone call. They could also use one of the many applications that allow them to record and send a video message to be watched later. In this aspect, the fantasy of mid-twentieth century Deaf people for whom the telephone was a constant source of inconvenience has finally been realized. However, a video relay service (VRS) is still another matter. The issue of VRS takes us back to many of the roadblocks that cropped up originally with Deaf usage of the telephone; while the ability to video chat is a huge development, customers must still rely on a hearing interpreter. In the case of remote interpretation, a Deaf person is connected with an interpreter who can see them and hear what they hear, so they can relay auditory information through Sign and then interpret that person's Sign into speech for their conversation partner. There are a number of technical complications and interpersonal issues that can easily occur within this system, making it considerably less ideal than it could be.

As is stated on the Sorenson Communications LLC website, Video Relay Services are supplied for free in the United States under the Federal Communications Commission (FCC), and businesses are required to accept VRS calls the same as they would telephone calls as mandated under the Americans with Disabilities Act (ADA) (2022). However, the services themselves still require customers to go through a registration process in order to utilize them. Additionally, the presence of the intermediary creates greater room for misunderstandings. When these miscommunications happen, it is usually considered the responsibility of the Deaf customer to confront the interpreter or their other communication partner about it, regardless of whether the miscommunication was the fault of the interpreter in the first place (Brunson, 2010).

This situation is not ideal on the part of the interpreter, either. Research has shown that interpretation scenarios are always more successful if an interpreter is able to familiarize themselves with their client and the situation they will be working in, an opportunity they are almost never given by the companies that employ them. While services do allow clients to opt to debrief their interpreters before starting an assignment, most of the time they are thrown into a job with little to no context as to what they are going to be doing. This combined with being expected to adjust to multiple assignments throughout the day is a source of major burnout among those who work in the virtual interpretation industry (Napier et al, 2017). There is also the issue of sightlines since having a proper visual of your signing partner is essential in any sign interaction. Even when two people are communicating with each other directly using sign over a video call, they must account for the physical and spatial limitations of doing so over video. This leads to people using an adjusted, more cramped version of sign that focuses mainly on the chest and up to account for these parameters.

In an ideal world, everyone would know at least one form of sign language, and communication between Deaf and hearing individuals would be downright seamless (besides all

the other avenues of miscommunication that come with any standard form of interaction). The world we live in is instead far from ideal, but the realities of modern videoconferencing have at least brought us a little closer by giving Deaf people the direct ability to communicate in their own language, an ability that had for so long been withheld from them. Likewise, the existence of Video Relay Services brings us a bit closer to bridging the considerable difference between Deaf and hearing telecommunication. In some ways, the VRS system could be seen as an extension of the former status quo which required Deaf people to rely on their hearing neighbors in order to use the telephone. However, the fact that these services are also now federally provided and often required under the Americans with Disabilities Act at least shows us that we have come a great distance in providing Deaf people with the telecommunications access they need.

Social Media

Over the past few decades, we have watched as the internet has acted as an unstoppable force of globalization, unifying cultures across the world while at the same time creating countless new avenues for conflict. With the power of social media, we are able to learn about and communicate with people whose experiences are vastly different than our own, and for better or worse this technology is now a constantly present consideration in all of our lives. Besides the overt ways in which it connects us, the internet also affects us in many small ways we are not aware of, and of course, things are no different for the Deaf community. However, the small and insulated nature that Deaf culture can often give us insight into the effect globalization has had on a group that was once considered isolated, both socially and linguistically.

Communication that utilizes smartphones and social media creates a notable evening of the playing field between hearing and Deaf people on the internet (Maiorana-Basas, 2014). Over the primarily text-based interactions of most social media sites, you would not know the status of

someone's hearing abilities unless they actively choose to tell you (Tannenbaum-Baruchi, 2017). On the other hand, there are also many video-based social media sites that act as empowering places for Deaf people to build community. As we explored in the previous section, Deaf people now have the access to instantaneous Sign Language communication which for so long had been out of reach. The ability to either remain anonymous or flaunt one's identity puts Deaf people, hard of hearing people, and signing people in an interesting position when it comes to negotiating their identity. In this respect, the internet is both a powerful tool for accommodation and an indicator of the long history of threats to Deaf culture.

When everyone is automatically assumed to be hearing at the start of any online interaction, there is an unspoken pressure on Deaf people to actively distinguish their identity within their online presence. At the same time, the visual nature of Sign Language often uniquely suits signers to the creation of online content, of both the educational and entertaining variety. Deaf creators must account not only for their local Deaf audience as they may have in the past, but also for their hearing and international audience. Like with many minority groups, the internet has become a powerful tool for spreading awareness of issues that had previously only been discussed within the Deaf community. This is a technology that's available to Deaf people of any age, a truly unprecedented level of access that allows any Deaf or hard of hearing person with a phone to find community online. As a result, there are also more Deaf celebrities now than ever before (Tannenbaum-Baruchi, 2017).

However, a 2022 study on phone use in Deaf and Hard of Hearing (DHH) adolescents found that their greater reliance on smartphones compared to their hearing peers can also lead to anxiety and social ostracization. The study dubbed this phenomenon "nomophobia", i.e. the stress response these youths have to the idea of not having access to their phones. This is already a feeling experienced by many teenagers at the thought of not having their phone, but for DHH

students their phone is not just a social lifeline, but an education and communication necessity as well. Because there is already evidence that smartphone overuse can lead to stunted social and mental development, this phenomenon is an important one to monitor among young people in the Deaf community (Awed et al, 2022).

As mentioned, online Deaf creators must negotiate their identities when considering the demographic makeup of their audience. In order to do this, many Deaf creators will adapt their signing through things like incorporating "street signs" (Tannenbaum-Baruchi, 2017), or signing and speaking at the same time in order to cater to both the hearing and Deaf sides of their audience. While this allows these creators to reach a wider audience with their videos, it also leads to the gradual loosening of Sign Language discipline. When a signer is forced to flatten certain aspects of their signing and culture when presenting themselves online, it could lead to people having an incorrect perspective on the Deaf community. However, there are also many Deaf creators who are deeply committed to sharing a completely candid version of the Deaf or CODA (Child of Deaf Adults) perspective (Tannenbaum-Baruchi, 2017). Like many minority creators online, Deaf creators are often the only representation their audience has for their community, and they must constantly balance that perception with their desire to reach other people like them.

So, while the ability of the internet to raise awareness of the strengths and struggles of the Deaf community is a powerful one, it does not mean that all Sign Language and DHH-related content is created equal. As with all internet content, we should be careful with acknowledging the source of any information we encounter in relation to Deaf culture and Sign Language, but we must also not let this discourage us from learning about experiences different from our own. Rather than viewing the Deaf community as a monolith that should move towards having as

singular a culture as possible, the internet allows us to celebrate the huge array of perspectives which exist regarding the DHH experience.

Looking Forward: Deaf Telecommunication in the 21st Century and Beyond

This final brief section documents various attempts in the fields of Artificial Intelligence and Robotics to comprehend and embody Sign Language. In some cases, these efforts have existed since as early as the nineties but are still not widely available on a consumer level due mainly to limitations in the ability of computers to account for the contextual nature of Sign Language. Modern advancements in embodying Sign do show some promise towards bringing Deaf telecommunication into a new era, mainly within the field of Virtual Reality.

Sign Language Recognition

The ability of Artificial Intelligence to comprehend and translate human language has become increasingly refined over a period of over eighty years (Parton, 2005). Natural Language Processors or NLPs, the systems which allow computers to decode and encode human (or "natural") language, have reached a level of advancement that would have seemed like fiction to people a century ago. Now it is considered commonplace to interact on an almost daily basis with AI which utilizes Natural Language Processing; be it through an online translator, a chat bot, or one of the many Spoken Dialogue Systems (SDS) that we might come into contact with over the course of the day.

Despite this level of development, which at times could even pass off a robotic intelligence as human (if only for a moment), it is also common knowledge that these language processing systems have their limits. Natural Language Processors typically function by creating a model for the categorization of language which is mathematically based in order for computers to understand. While the field of NLPs has existed since the 50s, modern progression with machine learning has made efforts toward processing language much easier (Feng, 2023).

Spoken language is another matter on the other hand, as there are many more variables to account for when comprehending spoken language. Even as Artificial Intelligences like Siri and Alexa have become increasingly normalized, many Spoken Dialogue Systems still notoriously struggle to comprehend people with accents or speech impediments. While the technology itself is very advanced, consumers will never interact with it in a way that's fully predictable within a lab setting. Simply put, although some conversational AI can certainly serve up responses that sound very human, they still cannot interact with every aspect of a conversation in the same capacity as a human being (Black et al, 2014).

With all of these limitations in mind, the ability of NLPs to comprehend Sign Language has a few obvious conditions. After all, Sign isn't simply reliant on nonverbal cues the way spoken languages are; it is made up entirely of nonverbal cues, with every small shift of the hand and micro-expression having potential grammatical meaning. A fully comprehensive Sign Language processor would need to be able to pick up on every single type of human expression, while current AIs only have the ability to understand a few simplified ones. When considering how to automate the interpretation of Sign, one must also consider that forms of Sign vary not just between the different languages used by different cultures, but also between the very concentrated regional dialects of Sign within each community. In short, Sign is a highly contextual form of language by nature.

What's more, most Sign Languages such as ASL do not have a widely accepted written form. American Sign Language does not use English grammar and can't be translated directly into English on the page, complicating an NLP's typical decoding-encoding process even further. Most efforts to create a Natural Language Processor that tackles Sign Language involve the creation or use of some existing set of symbols to correspond with certain signs. This is a very limited approach, since it can't account for the contextual nature of Sign and usually doesn't

cover more than a few hundred signs (Parton, 2005). Depending on the situation, a given sign could mean any number of things, whereas a Natural Language Processor typically needs to be able to translate each idea directly, a task which is already hard enough with spoken languages (which is why commercially available AI translators are notorious for providing vague or outright incorrect translations). Because of the grammatical nature of Sign, individual words often flow into one another or get combined completely, another hurdle of context for a Sign Language Recognition system to understand. As one researcher on a glove-based SLR project in New South Wales identified; “Sign segmentation problem is one that remains difficult, since deciding when one sign finishes and the next starts is not easy” (Kadous, 1996, p.2).

Taking these limitations into account, hardware that tackles communication in sign language tends to appear in one of two forms; cameras which are programmed to try to capture and digitize sign language, and robotic hands which attempt to embody Sign. On the software side, there are the NLPs and neural networking which would be required to allow a robot to come close to comprehending sign language.

Oftentimes these pieces of technology are combined to create a unified system that attempts to allow Sign to be represented in Virtual Reality. Because of the aforementioned high context requirement, most combinations of these still rely exclusively on fingerspelling in order to more easily facilitate a direct 1:1 translation (Parton, 2005). Not only does this put any potential users at risk of signing fatigue due to constantly having to spell everything out letter by letter, but this is also not actually communication with Sign Language. Most Sign Language Recognition systems that claim to be able to translate ASL directly into English require signers to sign in English in the first place by fingerspelling. While it’s impressive that SLR has reached even its current level of development, systems that rely entirely on fingerspelling are simply not equivalent to recognition of regular Sign Language. In reality, many of these projects seem to

rely on a fundamentally simplified understanding of Sign which does not take into account its complexities as a language.

Sign Language, perhaps more than any other type of language, is created and suited specifically to human physiology. It may be possible to encode every letter of an alphabet for a computer to understand, but it's impossible (as of right now at least) to encode every nuance and possible permutation of a human's movement. All of the issues that come with teaching Artificial Intelligence to comprehend human language are magnified when it comes to Sign Language for this reason. When looking at the efforts to bridge this gap between Sign and robotic understanding, it's easy to see that the robotic translation of Sign often requires a heavy simplification of the language. This is often also predicated on the assumption that ASL is grammatically equivalent to English. In reality, we should stop expecting for a Sign Language Recognition system to actually comprehend Sign Language (be that ASL, BSL, or any other type of Sign) or translate it properly into English. Instead, we should accept the level of development these systems have already reached and meet them on the terms of their own sets of symbols which we know they can understand, without expecting that what we're using will be at all equivalent to the Sign Language that humans are able to use with each other.

Embodying Sign

Alongside attempts to create a system for the translation of Sign Language, there have been numerous efforts to digitally embody sign language. These have manifested both in literal robot hands with signing capabilities of various levels, to projections of existing signers' movements using virtual avatars (Parton, 2005). In both cases, many of the same issues with other types of Sign Language Recognition still apply. In the case of robotic hands, they have typically not been able to do much more than fingerspell (Parton 2005) and more advanced versions cannot do much more than that due to the confinement of their movements. When a

robotic embodiment is trying to communicate to us with Sign, we have many of the same problems as when we try to sign back at them, which are solved by the creation of a hybrid type of sign which accounts for the limitations of robotic movement.

Virtual reality (VR) on the other hand, while presenting a lot of the same issues as embodying sign with robots, supplies a very promising avenue for the future of Deaf telecommunication. In many ways VR presents a more lifelike signing experience than signing over video; the embodiments and signing space are closer to what it's like signing face-to-face with someone. Consumer VR equipment has been available since the early 2010s; the most notable early piece of VR technology on the market was the Oculus Rift, released in 2013. One of the most popular VR applications (which is still in use to this day) was released for the Oculus Rift a year later, VRChat (Quandt, 2022). Both within VRChat and in other VR applications, it is common for small communities of signing people to develop due to the lifelike interactions allowed by virtual reality. Usually, these communities must adapt whatever Sign Language they use to the system they're communicating through according to the controller and user interface limitations.

Despite issues such as lack of articulation and occlusion of body parts, VR signing technology is ahead of other attempts at embodying sign in many ways due to its popularity with hearing people. The increased articulation of player models is seen as a general positive in the industry at large, and better signing abilities are usually a resulting side effect. While the VR industry is very much dominated by the interest of hearing people, it could also be the future of long-distance sign telecommunication. It is promising to see these small signing communities crop up in otherwise unrelated games, and although some Sign-specific educational applications of VR technology have existed throughout the decades it would be interesting for these smaller

communities to eventually build up into a VR social media application geared specifically towards the Deaf experience.

Conclusion

The introduction to Harry Lang's *A Phone of Our Own* (2000) is preceded by the following quote by telecommunications scholar Ithiel de Sola Pool: "To tease out the historical interaction in telephony between what was technically possible, economically profitable, and socially desirable is a puzzle worthy of scholarship." The quote is a powerful one to characterize not only the rise of the teletypewriter in Deaf culture but the history of Deaf telecommunications in general. The Deaf community has long had their communication needs withheld based on what is deemed either "useful" or "profitable" by the hearing majority. Regardless of whether a piece of technology would be revolutionary to Deaf and hard of hearing people, if it is not considered desirable by the wider populace then that technology could be held back by decades.

However, while this struggle has set Deaf telecommunications technology back considerably and in numerous ways, it has also created countless examples of Deaf technological ingenuity. From James Marsters experimenting with modifications to allow him to more easily use his home phone (Lang, 2000) to modern-day influencers finding new ways to spread awareness of Sign Language over social media; members of the Deaf community, whether out of necessity or foresight, have always found creative uses for the technology which does surround them. The visual nature of Sign means that the perception of these modes of telecommunication will always be mired in the historical context of Deaf history and oppression. This relationship is a "puzzle worthy of scholarship" which could supply years of writing going far beyond what is contained in this paper.

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References

Awed, H. S., & Hammad, M. A. (2022). Relationship between nomophobia and impulsivity among deaf and hard-of-hearing youth. *Scientific Reports (Nature Publisher Group), 12*(1) https://doi.org/10.1038/s41598-022-17683-1

Black, A. W., & Eskenazi, M. (2014). Real Users and Real Dialog Systems: The Hard Challenge for SDS. In *Natural Interaction with Robots, Knowbots and Smartphones: Putting Spoken Dialog Systems into Practice* (pp. 29-36). Springer New York.

Feng, Z. (2023). *Formal analysis for natural language processing: a handbook.* Springer.

Fitzgerald, T. J. (2003, December 18). *For the deaf, communication without the wait*. The New York Times. https://www.nytimes.com/2003/12/18/technology/for-the-deaf-communication-without-the-wait.html

Heller, T., Harris, S. P., Gill, C. J., & Gould, R. (Eds.). (2019). Deaf President Now Protest at Gallaudet (1988). In *Disability in American Life : An Encyclopedia of Concepts, Policies, and Controversies: Volume 1: A–L* (pp. 175–177).

Jensema, C.J. (1994). Telecommunications for the deaf: echoes of the past—a glimpse of the future. *American Annals of the Deaf 139*(1), 22-27. https://doi.org/10.1353/aad.2012.0973.

Kadous, M. W. (1996, October). Machine recognition of Auslan signs using PowerGloves: Towards large-lexicon recognition of sign language. *In Proceedings of the Workshop on the Integration of Gesture in Language and Speech* (Vol. 165, pp. 165-174).

Karwatka, D, (2008) Elisha Gray and the telephone patent controversy. *Tech Directions Magazine, 68*(3), 10. Retrieved June 2024 from: https://www.proquest.com/openview/e7611b4c80907a47e349bb779c6d8f16/1.pdf?cbl=182&loginDisplay=true&pq-origsite=gscholar

Lang, H. G. (2000). A phone of our own: The deaf insurrection against Ma Bell. Gallaudet University Press.

Maiorana-Basas, M., & Pagliaro, C. M. (2014). Technology use among adults who are deaf and hard of hearing: A national survey. *Journal of Deaf Studies and Deaf Education, 19*(3), 400–410. https://doi.org/10.1093/deafed/enu005

McLuhan, M. (1994). *Understanding media: The extensions of man.* MIT Press.

Mozzer-Mather, S. (2002). Certain distinct features of TTY conversations. *Sign Language Studies 2*(3), 255-280. https://doi.org/10.1353/sls.2002.0009.

Middleton, T. (1983). DEAFNET—The word's getting around: local implementation of telecommunications networks for deaf users. *American Annals of the Deaf 128*(5), 613-618. https://doi.org/10.1353/aad.1983.a506466.

Napier, J., Skinner, R., & Turner, G. (2017). “it’s good for them but not so for me”: Inside the sign language interpreting call centre. *The International Journal of Translation and Interpreting Research, 9*(2). https://doi.org/10.12807/ti.109202.2017.a01

Parton, B. S. (2005). Sign language recognition and translation: A multidisciplined approach from the field of Artificial Intelligence. *Journal of Deaf Studies and Deaf Education, 11*(1), 94–101. https://doi.org/10.1093/deafed/enj003

Quandt, L. C., Lamberton, J., Leannah, C., Willis, A., & Malzkuhn, M. (2022, June). Signing avatars in a new dimension: Challenges and opportunities in virtual reality. *In Proceedings of the 7th International Workshop on Sign Language Translation and Avatar Technology* (SLTAT 7). Retrieved June 2024 from: https://par.nsf.gov/biblio/10356532

Rochester Institute of Technology. (2024, June 13). *Hist 330 deafness and technology: Videophone Relay Services*. InfoGuides at Rochester Institute of Technology. https://infoguides.rit.edu/deaftech/videophonerelay

Sorenson Communications LLC (2022, December 2). Sorenson Video relay. https://sorenson.com/vrs/

SRI International. (2020, Dec 17). *75 Years of innovation: DEAFNET*. Medium. https://medium.com/dish/75-years-of-innovation-deafnet-32715ef43842

Tannenbaum-Baruchi, C., & Feder-Bubis, P. (2017). New sign language new(S): the globalization of sign language in the smartphone era. *Disability & Society*, *33*(2), 309–312. https://doi-org.libproxy.library.wmich.edu/10.1080/09687599.2017.1383034

Vincent, C., Bergeron, F., Hotton, M., & Deaudelin, I. (2010). Message transmission efficiency through five telecommunication technologies for signing deaf users. *Assistive Technology*, *22*(3), 141–151. https://doi-org.libproxy.library.wmich.edu/10.1080/10400430903519928