

# Understanding the Telework Experience of People with Disabilities

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To understand the lived experience of how people with disabilities telework in the United States, 25 people were interviewed. The participants included people who are blind or low vision, deaf or hard of hearing, neurodiverse, have limited mobility/dexterity, and have chronic health issues. The interviews focused on how they used video calling, screen sharing, and collaborative editing technologies to accomplish their telework. The interviews found ways in which design choices made in telework technologies interact with people's abilities, especially those who are blind or low vision, since the tools rely heavily on the visual channel to enable remote collaboration. A central theme emerged around how design choices made in telework technologies affect the digital representation of people's online activities in the video call interface: those who turn off their video (because they are blind or do not want to expend the cognitive effort to present themselves over video) are relegated to a static icon on a blank video frame with their name while those who are deaf and speak silently through a sign language interpreter never show up in interfaces that use active speaker detection to choose which video streams to display. Users with disabilities may avoid using screen sharing and collaborative editing tools which "leak" cues that disclose their disabilities. Because the interviews were conducted during the first month of the COVID-19 pandemic response, they also provided a preview of how the sudden shift to pervasive teleworking affected their telework experience.

CCS Concepts: • **Human-centered computing** → **Accessibility**; *Empirical studies in accessibility*

**KEYWORDS:** Telework; computer-mediated communication; collaboration technology; video calling; people with disabilities

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## 1 THE PROMISE OF TELEWORK FOR PEOPLE WITH DISABILITIES

Telework has often been promoted as a way to include people with disabilities into the workforce. Prior studies [26] have documented the higher rates of un- and under-employment of people with disabilities and documented encouraging ways that teleworking can help overcome some of the barriers to inclusive employment. Working from home avoids commuting, which can be a hardship for people with certain disabilities. It also affords setting up a work environment that is tailored to the person's abilities without the risk of being disturbed in a semi-public office setting. Working from home offers more control over the work environment, which can be especially

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important for people who are neurodiverse. And working from home offers more scheduling flexibility and proximity to support resources, which can be important in maintaining the well-being of people with disabilities. This combination of factors makes teleworking a valuable way of making work accessible to a wide range of user abilities.

However, more research is needed to understand the lived experience of people with disabilities who telework. Does telework deliver on the promise of integrating people with disabilities into the workplace? What challenges do people with disabilities face when they telework? What are the opportunities for improving their telework experience? Exploring these questions enables a current understanding of their telework experience and identifies ways of improving it. Updating our current understanding of the telework experience of people who are disabled is especially important relative the continually evolving technology used in teleworking. Especially with the recent deployment of so many new tools for supporting remote collaboration, it is important to understand users' experiences with the latest technologies.

The response to the COVID-19 pandemic during Spring of 2020 marks a recent societal shift toward teleworking. As the world abruptly converted to largely teleworking from home to contain the spread of the virus, many people's work practices were dramatically changed. Since these interviews were conducted during the first month of response to the COVID-19 pandemic in the United States, the participants were asked about changes in their telework experience in light of the fact that most of their colleagues were now teleworking.

This study contributes a current understanding of the telework experiences of people with a range of disabilities. The study focuses on the use of interactive collaborative tools, including video calling, screen sharing, and collaborative editing. A key contribution of this work is demonstrating how the design choices made in telework technologies around digitally representing the user and their activities has some subtle but important implications for how people with disabilities are perceived when using them. The analysis also illustrates how remote collaboration technologies interact with accessibility features, sometimes in ways that leak cues about a user's disabilities to their online collaborators. The interviews also offer an early indication of how the global shift to teleworking due to the pandemic response affected their own telework experience.

## 2 RELATED RESEARCH

The under-employment of people with disabilities is an ongoing economic and societal concern. Despite the positive effects of legislation such as the American with Disabilities Act, Ameri et al. [1] found evidence of ongoing employment discrimination practices when reviewing applications of people that disclosed disabilities. Recent statistics during the COVID-19 pandemic response showed that 1 in 5 workers with disabilities lost their employment, compared with the overall job loss of 1 in 7 [21]. Exploring how to enable people with disabilities to find and maintain employment continues to be a critical concern, and telework is often considered a way to make work more accessible to people with disabilities.

Telework and remote collaboration has been broadly studied in the CSCW literature (e.g., [2, 11, 16, 22, 23]). While telework can improve job satisfaction and well-being, it can also introduce challenges in work/life balance and overworking [12]. While telework has many implications for the general population, this study, and review of related research, focuses on how people with disabilities interact with telework opportunities and technologies.

### 2.1 Telework Opportunities for People with Disabilities

As teleworking technologies were emerging, the potential opportunities for including people with disabilities into the workforce were recognized [14]. Telework was seen as offering more control over the worksite, facilitating the inclusion of employees with severely limiting disabilities, and leveling the playing field for people with speech or mobility impairments. Fifteen years after this paper called for more research, it is important to see to what extent telework has been able to deliver on those promises.

A review of literature on telework for people with disabilities [3] found encouraging evidence for the increased benefits of teleworking, but also noted pronounced limitations on the kind of work roles that could be largely accomplished using information technology. They noted the importance of looking beyond just productivity to also explore challenges around social isolation and developing social capital while teleworking. They pointed to the need to develop teleworking at a policy level, and also called for further research in this emerging phenomenon. A special issue on telework and people with disabilities in the journal *Work* [17] illustrated a high overlap with known issues of teleworking in general regarding work/life balance and feelings of social isolation. A study that focused on the employees' perspectives on teleworking complemented most prior work that focused on employers, and identified issues beyond the technology that affected its utility [20]. They found that organizational factors, such as flexible scheduling and job restructuring, can be even more important than technology deployment in creating a telework practice that meets individual needs.

A survey of 373 employed people with disabilities [18] found that there was less uptake of telework (19%) than in the general population. Less than half of those who telework declared it as an accommodation for their disability, but those who did get more assistance from coworkers or services. They found that flexible scheduling was the paramount teleworking benefit, since it helped mitigate fatigue and pain issues. Of the 44% of teleworkers who said their telework was an accommodation for their disability, only 57% reported they were satisfied with teleworking as an accommodation, compared to 43% who indicated they were not satisfied. The authors speculated that this low satisfaction rate was related to other employment-related barriers associated with teleworking and advocated for more research to identify other ways to improve the telework experience for people with disabilities.

One concern raised about teleworking is the requirement to have ready access to internet technologies. Bricout et al. [6] found that uptake of internet technology is lower among the disabled population than the general population, which is a potential barrier to their ability to telework. Effective teleworking also relies on other social stakeholders beyond the person with a disability, and their manager at work is especially key for establishing a good work culture. Thus, both technical and social factors need to be considered in understanding how effective telework is for people with disabilities.

Recent research has documented the effort needed to make workplaces accessible to people with diverse abilities. Branham & Kane [4] found that people who are blind or low vision often bear much of the invisible work needed to make their workplaces accessible by proactively identifying ways to make the workplace more accessible. Similarly, Wang and Piper [25] documented how people who are deaf or hard of hearing worked with their colleagues to create an accessible workplace. Working remotely from home can leverage the work already done to make the home accessible to create an accessible remote workspace [5]. While these studies documented the work involved to make physical workplaces accessible, it is important to assess the accessibility of remote collaboration and telework technologies, to enable people with disabilities to access telework opportunities.

## 2.2 How People Use Telework Technologies

Studies have begun to look at the accessibility of telework technologies for people with specific disabilities. A study that looked at those who use alternative and augmentative communication (AAC) techniques found that teleworking enabled them to use their preferred communication technologies such as text-based email and instant messaging [19]. Buccholz et al. [7] looked at the remote communication experiences of people with communicative and cognitive disabilities. While they found the use and perceived value of remote communication varied among their diverse abilities, they also found that the choice of picking the medium that was a good fit for their abilities and enabled independent communication was important. They concluded that communication tools based on speech or picture symbols were opportunities for making communication tools accessible to this population.

Das et al. [9] examined how people who are blind or visually impaired use popular collaborative editing tools, such as Google Docs, when collaboratively writing with sighted colleagues. They found that, despite their popularity, there are aspects that are inaccessible, and were found to be neither easy nor robust to use in real life situations. They also identified how their use relied on social interdependence among their colleagues, which is shaped by the power dynamics and hierarchies of any social situation. Speaking up about problems with accessibility could be detrimental to the collaborative working relationship. Their focus on a widely used collaborative editing technology by people who are blind or visually impaired prompted the need to explore more general teleworking technologies across different kinds of disabilities.

Zolyomi et al. [27] interviewed autistic users about their experiences with video calling. They mentioned how sensory sensitivities, cognitive load, and anxiety contributed to making video calling challenging. They used coping strategies such as limiting their sensory inputs and attempting to mask their autism by adopting neurotypical behaviors. The cognitive effort around these challenges and coping strategies led interviewees to experience more stress, have less capacity to interpret verbal and non-verbal cues, and feel less empowered to participate.

An intriguing opportunity with mediated online communication technology is that people could have more flexibility in choosing how to represent themselves. Junuzovic et al. [15] compared audio, video, and avatar-driven representations in conferencing for work meetings. The participants preferred video representation for its rich conveyance of interactional cues, but they also exhibited sensitivity to how the representations affected their identity, finding the avatars to be too cartoonish for a work meeting. Another study looked at whether people chose to include visual cues of their disabilities in their avatars for online virtual environments [10]. They found that these choices could have implications for online work and social interactions for people with disabilities.

Telework is still a relatively new workplace practice, and the rapid pace of technology development, along with the calls in prior work for more research, encouraged the current study. An updated understanding of the telework experiences across the various types of disabilities would be helpful in guiding the development of future technology and workplace policy. Making telework more accessible is of increasing importance in light of the COVID-19 pandemic response that has made telework more pervasive.

## 3 INTERVIEWING PEOPLE WITH DISABILITIES WHO TELEWORK

An online survey was used to recruit people with disabilities who regularly telework for an interview. The survey was sent to people in the United States, recruited through an agency that explicitly serves people with disabilities and to online listings for accessibility related issues (e.g., a

corporate mailing list that supports employees with disabilities). The survey asked demographic information about the respondent (age, gender, description of disability, how much time they telework), and about their telework experience. The questions focused on their use of interactive remote communication, screen sharing, and collaborative editing tools in particular, as well as challenges and opportunities for improving their telework experience.

From the survey respondents, a subset was selected for in-depth video call interviews. Participants were selected to get a representative cross-section across different types of disabilities. They had an average of 5.6 years of telework experience, and 19 worked for an employer whereas 6 were self-employed or contractors. There was a wide range of job roles represented including software developer, lawyer, finance analyst, landscape architect, video editing, marketing, etc., of which five focused on accessibility work in particular. All participants resided in metropolitan areas from a variety of regions in the United States.

Table 1 summarizes the 25 people interviewed for this study, their age range, gender, description of disability, occupation, work status (35 hours/week or more is full-time, 10 hours/week or less is limited), and telework status (100% of work hours is full-time telework, less than 25% work hours is limited telework, and otherwise part-time telework). Participants are grouped by category of disability and their P# is according to their interview order. The participants included seven people who are Blind or Low Vision (BLV, shaded in blue), four people who are Deaf or Hard of Hearing (DHH, shaded in green), six people with limited mobility/dexterity (shaded in purple), six people who are neurodiverse (unshaded), and two people with chronic health issues (shaded in orange).

Table 1: Interview participants

P#	Age	Sex	Described disability	Occupation	Work status	Telework
P1	36-49	M	Blind	Software engineer	Full-time	Full-time
P4	≥ 50	M	Significant visual impairment	Database administrator	Part-time	Full-time
P5	≤ 35	M	Totally blind	Accessibility architect	Full-time	Part-time
P6	≥ 50	F	Totally blind	Accessibility testing	Limited	Full-time
P22	36-49	M	Legally blind	Website consultant a11y	Part-time	Full-time
P23	36-49	F	Low vision & PTSD	Event management	Full-time	Full-time
P25	36-49	M	Legally blind	Digital a11y consultant	Full-time	Limited
P10	≥ 50	M	Deaf	Global accounts mgmnt.	Full-time	Limited
P12	≤ 35	F	Deaf and ADHD	Comm. and marketing	Full-time	Full-time
P14	36-49	F	Profoundly deaf	Engr. project mgmnt.	Full-time	Part-time
P24	≥ 50	--	Hearing loss	Consulting	Limited	Part-time
P2	≥ 50	F	Multiple Sclerosis	Technology sales	Full-time	Limited
P9	≥ 50	M	Multiple Sclerosis	Consulting	Part-time	Full-time
P13	≥ 50	F	Spinal cord injury	Exec. Dir, not-for-profit	Full-time	Part-time
P15	≤ 35	M	C4 paralysis	Landscape architect	Full-time	Limited
P17	36-49	F	Quadriplegia	Finance analyst	Full-time	Part-time
P18	36-49	F	C4 quadriplegia	Policy and advocacy	Part-time	Full-time
P7	36-49	F	Tourette's & ADHD	Market research	Full-time	Limited
P8	≥ 50	M	Dyslexia	Customer support	Full-time	Full-time
P11	36-49	M	Dyslexia	Privacy law	Full-time	Part-time
P19	≤ 35	M	Autism, ADHD, Dyslexia	Mobile device developer	Part-time	Part-time
P20	≤ 35	M	ADD & Dyslexia	Software developer	Full-time	Limited
P21	≥ 50	M	Autism Spectrum Disorder	Customer support	Full-time	Full-time
P3	36-49	M	Multiple chronic disabilities	Cybersecurity Engr.	Full-time	Part-time
P16	36-49	F	Mult. autoimmune & chronic	UX writer	Full-time	Part-time

The neurodiverse participants included people with Autism Spectrum Disorder, ADHD, Dyslexia, and Tourette's Syndrome. There were 14 men, 10 women, and one respondent who preferred not to state their gender.

The interview guide of questions is included in the Appendix. Interviews were conducted over video calling (Microsoft Teams or Zoom), which participants were comfortable using through their telework. All interviews were recorded and automatically transcribed using the AI-powered transcription service offered within the video calling tool. These transcripts were edited for accuracy when reviewing the video recordings. Participants were offered a \$25 Amazon electronic voucher for what was intended to be a 30-minute interview. On average, interviews lasted 41 minutes (ranging from 28-65 minutes). Both the online survey and the interview were reviewed by the Institutional Review Board of our institution. All interviews were conducted between March 13 and April 8, 2020.

#### 4 INTERVIEW OBSERVATIONS

The interviews focused on their experiences with telework technologies for interactively collaborating. The questions explored how they used interactive remote collaboration technologies, such as video calling, and focused especially on screen sharing and collaborative editing tools. They also commented on how teleworking specifically interacts with their disability and the changes they have experienced since the COVID-19 outbreak made teleworking more pervasive. While many of the interview participants shared observations that overlap with general experiences in telework (e.g., social isolation, technology issues), this paper will focus on telework issues that are specific to people with disabilities.

Open and axial coding qualitative methods [8] were used to draw out the main themes from the interview data. Responses were first categorized according to what aspect of teleworking it applied to (e.g., video calling, screen sharing, work practices, pandemic response), and further refined according to specific attributes and recurring themes around challenges and opportunities (e.g., being able to see everyone easier, problems interacting with accessibility features, social pressure to turn on video during pandemic).

Participants were asked to rate their satisfaction with their telework experience on a scale of 1 (completely dissatisfied) to 7 (completely satisfied). The average of responses was 5.7 with only one participant (4%) indicating a 4 or lower. This high satisfaction rate sharply contrasts with an earlier study with a 43% dissatisfaction rating [18]. Perhaps the developments in technology, workplace policy, and social acceptance have made teleworking dramatically more satisfying in the intervening seven years, and this change confirms the need to update our understanding of telework over time.

The findings are organized according to: the user experience of people with disabilities in video calling, how remote collaboration technologies interact with accessibility technologies and practices, how screen sharing and collaborative editing affects their user experience, and how the response to the COVID-19 pandemic affects their telework experience. Quotes from the interviews will be used to illustrate the details of their telework experience, which leads to design implications in the next section.

##### 4.1 The User Experience of People with Disabilities in Video Calling

While the participants talked about their experiences with a number of different remote collaboration technologies, including Slack, texting, and phone calls, most of the discussion focused on various video calling tools that they used, including Zoom, Microsoft Teams,

GoToMeeting, and Cisco Webex. Participants described how video calling enabled their telework, while also mentioning challenges that arose in interacting with their diverse abilities.

*4.1.1 Video calling can make participating in meetings accessible.* Participants mentioned several ways in which video calling made participating in meetings more accessible. Attending meetings remotely of course removes any mobility concerns of getting to the location of an in-person meeting. But video can also afford attending meetings in positions that accommodate limited mobility:

*I have these... prism glasses. And if I'm laying flat on my back, I can have my laptop on like a little lap desk and have my back completely flat and put these on and I can see and I can type. P13 (Limited mobility)*

The prism glasses reflect the view path of her eyes so she does not have to sit directly in front of her laptop, but can operate it lying down with the screen oriented perpendicular to her face. Because P13's prism glasses obscure her face, which means other meeting participants would not be able to see her facial expressions anyway, she is comfortable turning off the video, which enables her to participate in the video call without revealing her unusual work posture.

Besides physically enabling participation in meetings, video calling technology enables people with disabilities to feel more comfortable participating in meetings. Two users with limited mobility commented specifically on the advantages of using a virtual background feature that digitally replaces the background with a selected image:

*But it's kind of fun to pick your own, so that... sometimes, you know, just having medical equipment behind you or something. P18*  
*You know you can pick from a number of conference room backgrounds or, a beach I think it's one of 'em... It makes you feel more confident and comfortable as opposed to not knowing what might be behind you, or what you might be showing... I would almost never use video before they came up with the options for the backgrounds. P2*

People who are neurodiverse appreciated the flexibility and control that video calling offered in accommodating their diverse abilities, especially being able to choose to not share their video:

*To the group of developers I work with, 5 of us... we'll do a group call now over Teams. About half of us have video out. P20*  
*Sometimes I will put myself on video if it's someone that I'm very comfortable, you know, tic-ing and being myself with. Otherwise, suppressing and things is a little bit difficult for me to do for very long. P7*  
*I prefer the video calling just because I can kind of control the environment more. P21*

Turning off video enables people who are neurodiverse to manage the cognitive effort needed for impression management, or in P7's case, enables her to avoid sharing the motor tics associated with Tourette's syndrome.

People who are DHH also pointed out some advantages, even over face-to-face interaction, of the frontal view and the cues of who is speaking in video calling:

*Because everyone's participating on Teams and everyone's on video and it's easier to tell who is talking, it's easier to participate in those conversations by seeing people's faces directly rather than looking at one big meeting room full of heads and not really being able to see people's faces P14*

*What I like about Teams is whoever is talking pulls up onto the screen and I see the blue circle [speaker highlight]. And it's also helpful for the interpreter—they're not trying to guess based on what they hear. P10*

In contrast to the oblique views of people's faces when sitting in (or even video calling into) a meeting room with several people at the table, video calling when everyone is remote (as in the pandemic conditions at the time of the interviews) gives them full frontal views of each person, affording more effective lip reading and speaker identification.

Video calling increases the accessibility of meetings by enabling more flexibility in how people join and participate in meetings. The ability to attend meetings while lying down, turning off video, or muting audio enables people to manage their diverse abilities while engaging in a meeting. The frontal views of individual faces and explicit cues for who is speaking can make it easier to lip read and identify who is speaking. These are some ways video calling can help level the playing field among meeting participants with diverse abilities.

*4.1.2 Accessibility challenges with video calling.* Given the inherently visual nature of video calling tools, people who are BLV readily discussed challenges with using the tools. Most of these participants would typically not turn on their video camera to share their video as part of the video call, as explained by these comments:

*I usually have it off... Because you know, obviously, being visually impaired, camera doesn't mean much to me. P4*

*I don't want to be embarrassed by doing something because I'm not thinking that I'm in a room full of people because I don't feel like I'm in a room full of people. P1*

*You know a lot of my work is for blindness organizations, so people just don't tend to turn on their monitors, and then I also work from home, so a lot of times I'm working in my bathrobe. P22*

People who are DHH encounter additional challenges around seeing and being seen when using video calling:

*If people decide not to open their cameras and not to be visible, I got a problem. P24*

*Being deaf, I normally mute myself and thus I am always hidden away out of sight even though I turn my video on – and when I speak [through my ASL interpreter], my interpreter's icon shows up, not me. P12*

Because P24 relies on lip reading, she relies on other participants to turn on their video and have properly adjusted lighting to be able to clearly understand them. Furthermore, P12's comment points out that since many video calling tools switch video views based on the current active speaker, those who use sign language to communicate with an American Sign Language (ASL) interpreter who speaks on their behalf do not generate any sound and thus never trigger having their video window displayed. And when she did speak through her ASL interpreter, it was their interpreter's video or icon that visually appeared, not her own video stream. For this user group, their visual and aural participation are actually segregated into different meeting participants, while the technology expects audio and video to always be unified. She further commented:

*Repeated incidences of this in nearly every meeting... has resulted in me feeling like I am being "erased" unintentionally by the technology's prioritization of audio during virtual meetings. P12*



People who are neurodiverse mentioned the increased cognitive effort incurred by video calling:

*So I'm always cautious with my video 'cause I have to be in the right mind state to be able to focus on it. At least I feel that I do. P21*

*When you have phonic tics, every time you tic, even when you're on mute, you'll get a message from the very nice microphone and AI computer... telling you, 'Hey, you're on mute.' and I'm like 'Yes I know I'm on mute and it's just because I'm sniffing' and it is very unique to people with Tourette's... It's a little bit like reminding you how weird and different you are. P7*

P21's comment reflected how those on the autistic spectrum have to be ready for the cognitive effort to maintain eye contact and be aware of their video presentation if they turn on their video. In P7's case, muting her mic to suppress sharing her phonic tics on the video call was still called out by the AI notification intended to warn people of speaking while muted, reminding her of the very activity she was trying to suppress.

The accessibility challenges of video calls varies according to people's diverse abilities. Because people who are BLV may not be able to perceive video calls, they typically do not turn on video during video calls or may prefer using the phone for audio only connections, since their phones can be optimized for one-button calling into meetings. People who are DHH struggle to be seen in video calls, especially if they silently communicate through ASL, which can mean that their video window is not displayed. And people who are neurodiverse may want to manage how much video and audio to share in a meeting, since it can take extra cognitive work to manage their visual and aural presentation in meetings.

## 4.2 How Video Calling Interacts with Accessibility Tools and Practices

The interviews showed how video calling may have problematic interactions with common accessibility tools and practices such as screen readers, voice command input, sign language, and captioning.

*4.2.1 Interactions with screen reading and voice command technologies.* Screen readers can be a primary way that people who are blind perceive information from their computers. However, its voice output can compete with the voice dialog also being transmitted by their computers during video calls. This can especially be a problem when screen readers (such as JAWS) are being used to read out the slides being presented during a meeting at the same time that the presenter is speaking. Participants described a few different strategies for dealing with this problem:

*...listening to someone speak and JAWS at the same time, so if I sit there and I try to read a presentation while somebody is talking about it, I will definitely miss what they say. P1*

*It's kind of a give and take type of thing where people are talking for a while and then I use the screen reader, then people are talking for a while, then I'd use the screen reader. P6*

*I have a VoIP phone right here... if I was using Webex for example, I will join the call but I will have the audio go to my phone. So that way I'm listening, I can kind of flip back and forth between listening to JAWS and listening to the phone here. That helps me a little bit. P4*

Clearly, trying to manage two independent audio streams coming from the computer at the same time is a challenge. P22 mentioned strategies of either turning off the screen reader during meetings, or alternating times of listening to the screen reader and to people talk. P4's strategy

separates the audio to two different devices, thus creating different audio spaces to which he could selectively listen.

People with dyslexia also mentioned using screen readers and experiencing challenges during presentations:

*If they do something like that [share screen with lots of text], then I'll use the text to speech to read it with, but that's not usually the case. Most of the time when people are sharing things like that, they just send it and then you read it. P8*

Voice command technology is also often used by people who are BLV and those with limited mobility and dexterity who cannot operate a computer keyboard. In remote meetings, voice commands present the corollary problem of sharing the voice input channel to command the computer or talk with other participants:

*...where their time is limited and also just professionalism where... it's not standard for somebody to say, 'Wait a second. I need to talk to my computer'. P18 (Limited mobility)*

Using audio output or input as a modality for enabling accessibility becomes problematic when participating in remote meetings where audio is also used to communicate with the other participants. This issue affects people who are BLV or dyslexic that use screen readers as well as people who are BLV or have limited mobility who use voice commands with their computers.

*4.2.2 Interactions with sign language interpreters and captioning.* People who are DHH also raised substantial issues in absorbing all of the information being transmitted in video calls. While recent, AI-powered technology for providing real-time captioning was greatly appreciated, this user group still preferred to augment live captioning with American Sign Language (ASL) interpretation:

*Yeah, uh, the captioning is good, but it's not so good that I can go solo. P10  
...the acronyms, the business language, there's no ASL, we have to develop work signs for some of this. If I were to look in my world and think of a pure ASL translation for 'treasury', 'finance', and 'cash', it would be the same sign. But for my understanding, those are three very distinct, specific words that I need to know. P10*

*There's a lot of nuance with facial expression. That is where I feel like ASL interpreters really play a very critical role. They do important work, and it's next to impossible for a computer to replace a human interpreter. P12*

*I can watch my interpreter and I can double check what the specific word that's being used with the sign that I'm seeing and I'm able to absorb those at the same time. Also later on when I'm writing emails, I can use the same vocabulary that we were using in our conversation--without the captions, I don't have the exact words. P12*

Participants pointed out both the importance and challenge in managing their view of videos, ASL, and captioning. Visually processing what amounts to two different languages concurrently is cognitively demanding. Plus, since video calling applications may not consistently show the ASL interpreter's video window (if using an active speaker algorithm for showing video windows) and their ASL interpreter's video window may become too small to read in meetings with many people, both P10 and P12 described elaborate methods for using a separate video call on a dedicated device (e.g., phone or tablet) solely for their ASL interpreter, shown in Figure 1. While this approach insures an exclusive video connection with their ASL interpreter, it means that they

must have a separate device using a different video calling application to connect to the video call meeting of their team, plus include their ASL interpreter into that team meeting video call.



Figure 1: Video call setup for a person who is DHH that shows a dedicated device for a video call to their ASL interpreter and the variety of visual information they need to integrate to participate in the video meeting.

Another problem is managing the visual layout of these accessibility resources. The video of the person speaking, the ASL interpreter's video, and the captioning text are not typically visually close to each other, which makes it hard to view them simultaneously. Furthermore, because the person speaking changes throughout the meeting, it can be hard to orient toward the speaker's video throughout the meeting. Many current video calling interfaces do not group these items together, adding to the cognitive load of processing the visual image of the speaker, the ASL interpreter, and the captioning text.

There are also several practical challenges around connecting with and scheduling their interpreters:

*...it depends on the type of phone that my interpreter has.... Some interpreters have Androids, some have iPhones. Whatever my interpreters have, I will use either Google Duo or FaceTime.  
P12*

*I normally have one interpreter scheduled every day from 8:30 to 5:00. So any meetings that start early or run later I have to adjust the start time and the end time and make sure that interpreter's available. The other thing I have to do is to make sure that... I don't have a single interpreter who is working more than an hour and a half continuously. P10*

Furthermore, including the ASL interpreter into corporate calendar appointments, which is necessary to give them access to the meeting, resulted in some practical issues. Rescheduling meetings to a different time or day often meant dealing with a different interpreter scheduled for the new time. And replying to the meeting participants with follow-up emails ended up including the interpreter into email threads that are irrelevant to their work.

People who are DHH identified a range of issues concerning their ability to process all the information being transmitted by real-time captioning, their ASL interpreter, and people in the meeting; their need to schedule their ASL interpreter and include them into the meeting invitation; and their silence leading to invisibility in video calls even when they speak (through their ASL interpreter).

### 4.3 Challenges with Screen Sharing

Screen sharing, where one person shares their computer screen (or specific application window) so that all the others can see it as part of the video call, is a common practice when remotely collaborating. Current implementations of screen sharing have interactions with specific peoples' diverse abilities.

*4.3.1 Interactions with accessibility adaptations for people who are Blind or Low Vision.* Given the highly visual nature of screen sharing, it presents several challenges for people who are BLV. Section 4.2.1 already described how using screen reading to perceive what is being shared interferes with the shared audio of the meeting. Furthermore, screen readers may have trouble focusing on the content being shared, as described by this participant's experience with the JAWS screen reader:

*JAWS has the ability for OCR [optical character recognition], so I would probably try and OCR against the screen and see if I'm getting anything that's going on there. It allows you to either OCR the active application window or the full screen, so it'd probably be hunting around a little bit trying to figure out what was on that screen. P4*

People who have low vision often use screen magnification and/or inverted colors to help them see their computer screen more clearly. These adaptations can have problematic interactions with screen sharing:

*Say you were the presenter and you had slides. I could use my screen magnification to see those slides. Or I might take screenshots and then OCR those slides at a later date. P22*  
*I may even need to turn off my inverted setting to just return it just to be able to appreciate what exactly's being shared on the screen P25*

These quotes illustrate the additional work involved in managing their modified display settings with regard to screen sharing, sometimes involving turning off their modifications to perceive the context of what is being shared.

Other approaches require asking for assistance from the presenter, which is socially problematic:

*'Hey, can you explain what's going on', or I'll stop people and ask questions and just say, 'I'm sorry, I'm not following'. P1*  
*I typically ask for the PowerPoint ahead of time or any type of documentation that they're sharing, like Excel file or whatever that they have, so I can actually go through it with them as they are talking through their presentation, or after the meeting. P5*  
*So I tend to often ask people, 'Can you make that bigger you know? Can you, can you zoom in on that Excel or on that PowerPoint? Can you make the context a little bit bigger?' So that's probably my biggest challenge and frustration with screen sharing is having to constantly ask to make something bigger because I can't see it... I feel bad 'cause I feel like I have to ask every time. P23*

It is notable that P23 was not aware of the magnifier tool available on her computer platform that would allow her to magnify her own view of the shared screen, rather than asking the presenter to enlarge it for everyone. When I told her about the magnifier tool, she tried it out and found that it helped, with some configuration. This instance reflects a common problem that people are not aware of accessibility tools, even when they are built-in to the computer platform. There were also a few other instances during the interviews where I introduced participants to a

technology that might help address a need they just described. Even among this rather technology savvy population that had figured out how to master teleworking, they were not always aware of technology solutions that could help make their work more accessible. Basic awareness of the relevant accessibility tools continues to be an ongoing concern for this user population.

Those who use accessibility adaptations to view their screens encounter some specific challenges when they share their screen out to others. P25 shared a few different interesting details of his experiences when he shares his screen for others to see in a meeting:

*There are all sorts of challenges associated with being able to share my screen in a way that, because I'm magnified and [color] inverted ...*

*But when it becomes time to share my screen and get to the slide deck, you know, I'm just up front with them and I say, 'OK, as I mentioned I am visually impaired. It's helpful for me as a presenter to be able to refer to my large screen display. So I will be going off the camera' [of the laptop]*

*If I'm doing the sharing, I need, it requires me, or compels me, I'll say, to be up front with my audience.*

P25's comments demonstrate his awareness of how screen sharing may make his visual disabilities more apparent to the other meeting participants. He may turn off his display modifications to avoid confusing his meeting colleagues, or feel a need to explain his actions relative to his visual disabilities.

Others pointed out how their screen reader would lead to unexpected behavior when they shared their screen out to others:

*The default behavior for JAWS, I believe, is if you go to a web page for example, JAWS will start reading the webpage just automatically and once it starts doing that it will move a highlight around on the screen and then once it gets to the bottom of the page it will automatically scroll the page. And of course, neither of those is an expected behavior for a sighted person. JAWS also will automatically move focus. P1*

*If somebody said to me, 'I've got control of your keyboard. I know you gave me permission. I'm trying to look at this page, but wow, this thing is jumping around on me. What should I do?' I would probably turn off speech with JAWS. P4*

These quotes illustrate how screen readers can cause the input focus to move around in automated ways to proactively read them out, which can be confusing when sharing screens with other meeting participants who are not familiar with screen readers. It is especially confusing when giving another user remote control of a shared screen that is being driven by a screen reader.

One user, P22, described how he uses a feature in JAWS called Tandem, that enables him to hear the screen reader from a remote person's computer, providing the audio equivalent of screen sharing, although it introduces a delay which can be problematic:

*So when I use JAWS Tandem, I would be on the telephone with the person... and essentially I'll get a code to give the recipient on the other line, and then I will have control of... their PC using JAWS... Yeah, it's slower, so the Tandem session is a little bit behind... Let's say they're down arrowing through a series of paragraphs of text. I might be hearing what they're hearing 15 or 30 seconds afterwards... they're hearing things immediately, but I'm still waiting for their response, so sometimes they get a little impatient*

People who are BLV try to perceive screen shared material by using a screen reader (whose audio must be managed relative to the ongoing conversation), using accessibility adaptations such as screen magnification or color inversion, or through social requests for sharing things in advance or talking through the material. Sharing out their screen with others can reveal the display adaptations (and thus their visual disability) or cause confusion because of input focus movements driven by their screen reader. On the plus side, people who are BLV will sometimes use screen sharing to get help working through inaccessible interfaces or demonstrate inaccessible issues so that they can be fixed.

*4.3.2 The Impact on visual layout for people who are Deaf or Hard of Hearing.* Those who use an ASL interpreter described how important it was for their interpreter to also be able to see any screen sharing that occurred during a meeting:

*This is why it's so important for me to be able to have the interpreter log into Teams, have the full view with the Teams presentation, particularly if there's a shared doc on my laptop. I know that the interpreter can see it. They can use that to help translate for me and they have visibility to things that otherwise just listening might not make sense because it's a [company] acronym or business language. P10*

Building on the comments on how important it is to see the faces of meeting participants, and especially their ASL interpreter, they commented on how screen sharing often interacts with the participants' video images:

*When I share my screen, your and my video will minimize to less than an inch tall. And that's a huge issue for me, because as a deaf person I'm leaning way in. I'm trying to figure out what's being said, and it's just hard to understand. It's like turning the volume down. You have to lean in and try to train your ears to listen to a very quiet voice. P12*

*In PowerPoint, there's a laser pointer function, it's very tiny. Or somebody will just be using the mouse icon and clicking around and they'll start moving very fast... I will stop the presentation. I will ask them if they can please very quickly go in and manage their mouse presentation to increase the size and add color... Because otherwise I'm visually trying to follow what I see on the screen. I'm following the interpreter at the same time and I'm keeping an eye on the captioning. P10*

*What if I were able to decide on how big the PowerPoint slide was and your face... That would be great because quite often the PowerPoint presentations are pretty straightforward and my screen is big enough that I could go to full screen and see both things pretty well. P24*  
*We did the screen sharing in the meeting, and one or the other. You got the PowerPoint slide or you've got the person. P24*

Beyond the visual challenges that video calling already presents to people who are DHH, screen sharing can add more challenges by shrinking the size of video windows or adding other visual elements that must be cognitively processed as part of the meeting.

*4.3.3 Complexity and exposure for people who are Neurodiverse.* For people who are neurodiverse, screen sharing also added some challenges on how to process the additional information being shared:

*... especially because with ADHD and Tourette's, sometimes I'm distracted or I'm super focused on what I'm sharing and I may not be paying attention to the chat window or things like that... it's harder for me to switch task to pay attention to the question people are asking me in the chat while I'm also trying to present. P7*

People found that sharing their screen out to the others in the meeting was very effective, although one concern was voiced about not wanting to share their live notetaking:

*So I'll do a screen share of my whole monitor, and then I'll remote into my dev box and then I'll walk through the code. Usually it works pretty well, so we can talk through the code and we're not really doing video chat that point. P20*

*I'm not as good at organizing words, language on the fly in written form... My notes are just of poorer quality than my non-dyslexic colleagues. So, if I'm screen sharing, I'm not going to screen share my live capture notes in a meeting. So that would be something that's a challenge for me that I particularly try to avoid doing. P11*

Screen sharing can add some complexity that people who are neurodiverse need to manage while participating in a meeting.

**4.3.4 Difficulty sharing out screen for people with Limited Mobility/Dexterity.** While people with limited mobility/dexterity appreciated being able to follow along when others shared their screen in a meeting without any issues, their limited ability affected how they could share their screen with others. P18, who is unable to move her arms and primarily uses voice to control her computer, described several different experiences around sharing her screen:

*For me right now, if you wanted me to share my email screen or something like that, it would be like 20 commands for me to get there. And then let alone actually interact with my shared screen to scroll down. ... just scrolling down, is a stop and turn off microphone or turn on my microphone and scroll. It's not natural.*

*If I am with people I'm very comfortable with, I'm able to share my screen pretty easily. I just have to say, 'OK, need to give the commands.'*

*If I can't run a meeting or be independent on a virtual meeting? ... Then that's a problem for me. It's suddenly, I have to bring attention to my disability in a way that I don't think I normally have to.*

For those that do not have the motor capability to launch screen sharing, it currently involves interrupting the meeting to execute a series of voice commands, which seems like a time-consuming distraction, and can draw unwanted attention to their disability.

#### 4.4 Challenges with Collaborative Editing

The advent of cloud-based collaborative editing features has enabled team members to efficiently and collectively edit files together in a way that affords maintaining awareness of who is making what changes. It even allows interactively editing a file together, sometimes during a meeting. While the interview focused on interactive collaborative editing during meetings, participants often included their experiences with asynchronous collaborative editing as well.

**4.4.1 Visual complexity for people who are Blind or Low Vision.** As documented in prior research [9], collaborative editing presents obvious challenges to people who are BLV, based on the highly visual nature of the interface. Participants described details of the challenges they encountered while collaboratively editing, especially how it interacted with their screen reader:

*... if I get it wrong, everybody knows I got it wrong. In other words, if I'm trying to add text, but it's at the top of the document instead of down in section 2, subsection 4, it just looks bad for me. P4*

*When I have used the revision features, it didn't read well with JAWS and I found it to be more confusing, I found it to be really hard to use. And I don't know if I was doing something*

wrong. I suppose I could have increased the verbosity of the way that it read out text, so if the text was colored, I would have heard changes in color or strikethrough. P22

If I... choose new comment, the text that I enter into the comment field was not read at all by JAWS. So I basically just had to just type and hope. One thing I did was go to another text editor and write a comment and then just copy and paste it in. P1

The comments is kind of difficult, and editing is a tedious task. I don't find editing Google Docs that great... But finding the exact comments that someone has written and then sometimes they will make something in a certain color which isn't very helpful. It just takes a lot of work to do, but I've done it on a few occasions P6

While the visual challenges are readily apparent, only P1 offered a workaround that was still rather tedious:

*If you just 'Select All' in a Word document and paste it into a text editor, it will paste in the comments and they'll be in numbers with brackets and so you can kind of if you just look at the plain text representation, the comments are actually a little easier to follow.*

4.4.2 Cognitive complexity for people who are Neurodiverse. While people who are neurodiverse can see the collaborative editing interfaces, some find it cognitively overwhelming:

*Many people editing one document and that many people putting comments, I think can be overwhelming to look at, especially someone with ADHD for sure. P7*

*Collaborating with colleagues across [company] on a specific document, it just visually gets very complicated... when you're collaborating with four or five or eight people, it seems to just kind of be overwhelming for everybody. P11*

*Someone setting a Google Drive document or a Word document and they've made changes. I've not found a good way to stay up to date with those changes... How do you know what changes should be relevant to you or not? ... I've seen where they have sort of like blanket alerts like, 'Hey this person made a change', but then every time someone makes a change which could be as simple as like file save... P19*

*I tend to try to not be the editor for that reason. Not being the person who's holding the pen, so to speak... But if I'm trying to incorporate other people's feedback to turn that into viable language. Or just regardless of when working with, probably the person I'm working with is going to be better at doing that than I am based on my disability. P11*

Their observations reflect that collaborative editing is a fairly complicated process that can also involve distracting notifications, requiring a lot of cognitive effort that can be taxing to those who are neurodiverse.

#### 4.5 The Effects of the COVID-19 Pandemic Response

The COVID-19 pandemic response in Spring of 2020 abruptly shifted most computer-based work to telework from home. Since the user participants in this study regularly teleworked beforehand, this shift was not a new experience for them. But since the interviews were conducted in March and April of 2020, they reflected on how *their telework experience* changed now that *everyone else* was teleworking from home all the time.

Some of the participants were in job roles that were not office-based, but out in the field or working with other colleagues who are remote, which is perhaps what enables them to telework in their positions in the first place. Thus, their work was not dramatically changed by the global shift to telework, and seven people reported that their work did not change much:



*Being on the spectrum, working from home a lot already. I haven't seen too much because, again, a lot of the people who I might work with or would work with are also remote. P19*

Participants shared observations about the changes, challenges, and opportunities brought on by the sudden shift to telework, and how their experiences gave them a different perspective on that transition.

**4.5.1 Increased use of video.** The most common change cited is the increased use of video during meetings, probably prompted by the lack of seeing and socially connecting with colleagues in the office:

*Because we are doing it more often, we kind of want to see one another, so I think that's part of why we probably did a video chat or a video call the other day... we're trying to use different methods of still being more present P15 (Limited Dexterity)*

*Although with this COVID stuff, it's, more [company] people turning on their cameras... so it'll be interesting to see if [company users] retain to turn on cameras for stuff like this P20 (Neurodiverse)*

*I think the video thing is going to be a little bit of a tweak, maybe because I have to be camera ready more. P2 (Limited Dexterity)*

*With everything being remote now on Teams meetings, things like that with everyone wanting that human connection, there's been more of a need, or an ask I should say, to have video on. So that's happened more recently. But that's not something I normally do. P23 (BLV)*

While an increased use of video seems like a natural response to the sudden shift to telework, P2's and P23's comments point out that people with disabilities who deliberately did not turn on their video cameras are now feeling more inclined to comply with the sudden social interest in having everyone's video camera on.

**4.5.2 Challenges in the shift to telework.** Having everyone shift to full-time telework also introduced challenges to the participants:

*For some reason, people feel the need to have even more meetings... I'm like, dear God, I'm in back to back meetings 6 to 7 hours out of my day. I'm working 15 hour days now to get my work done... With my increase in meetings, I haven't even been able to use my Dragon software, which was provided to me as a part of my accommodations. Because I don't have the battery life in my headset and I'm in so many meetings that my battery is completely used up P23 (BLV)*

*The one thing that comes up, of course routinely and repetitively is person by person, their Wi-Fi or their Internet connectivity is variable. And so it's a constant conversation I'm having with interpreters as well as if I see a slowdown... people who were telecommuting before on a regular basis, but the family wasn't: family was off to school, family was off to their job. P10 (DHH)*

*So right now with everybody being on the Internet and working from home and streaming and using Netflix, it has slowed down bandwidth for a lot of people which I know has been a huge issue for deaf individuals who rely on video quality for communication. P12 (DHH)*

*...virtual connectivity mechanism, this is all very abrupt, so I'm trying to learn this right away and then, unfortunately me as the kind of user I am with, with limitations, has made that a little harder. I can't be the one who teaches. P18 (Limited Dexterity)*

*I feel like my ADHD community lately... There's been a lot of talk on the channel is about, 'Oh my gosh, how am I gonna do this? How am I gonna work from home every day because there's so many things distracting me at home?' P7 (Neurodiverse)*

These observations identify a range of challenges to the telework experience for people with disabilities. Increased meeting time drained the battery life of a wireless headset rendering P23's Dragon voice command software unusable. P10 and P12 commented on how the increased load on residential internet service degraded video quality, which is a crucial issue for people who are DHH, especially in communicating clearly with their ASL interpreter. The ability to quickly absorb the scale of change, which was a challenge for all of us, can be especially difficult for people who need more time to work through changes. And people who are neurodiverse and sensitive to changes in their environment are dealing with new working environments that can have more distractions.

4.5.3 *Opportunities in the shift to telework.* Participants also saw some opportunities for how this shift could help improve their telework experiences:

*One of the neat things right now about COVID-19 is, more people are turning their cameras on and I feel like I'm able to connect with somebody and understand them a lot more when I have all of the visual cues. P11 (Neurodiverse)*

*It's so much more convenient for me, I cannot tell you, because now everybody, it's equal. Everybody's doing exactly the same thing I'm doing. They totally get it now. P16 (Chronic Health)*

*Punctuality... it's kind of weird, everybody is way more punctual now. It sounds crazy, but it's true... No one's getting stopped in the hallway and a side conversation, or you know, stopping to get coffee on the way. P14 (DHH)*

*Some social talk... it's still happening and I think it's more inclusive for everyone because it isn't just a small group in the corner having that conversation, everybody is able to participate. So, ultimately, I think it feels better, at least to me. P14 (DHH)*

*So I think it may be, one of the good things to come out of this unfortunate situation we're in is that I think there's going to be a bit of a sea change about people's ideas about how connected you can be when you're not in the same room. P13 (Limited Dexterity)*

*It's going to be interesting to see if, out of all this COVID stuff, that [company] as a whole kind of rethinks about the efficiencies of teleworking and maybe is able to value that more instead of only, 'There's a few people out there that do it and everybody else goes to the office'... We're kind of used to this idea of having to work out of our offices, but there's no support for this. Mostly up to us to deal with. P20 (Neurodiverse)*

Several of these comments came from work cultures where teleworking was offered, but perhaps limited in frequency or not fully embraced. Having had to switch to telework out of necessity and seeing how effectively it can be done (even under circumstances that were stressful for other reasons), several participants saw an opportunity for teleworking to be more broadly accepted, which could improve their telework experience. Other studies are also beginning to document how the pandemic response has surfaced some benefits of expanded work from home opportunities for people with disabilities [24].

4.5.4 *Perspectives of people with disabilities who regularly teleworked beforehand.* As people with disabilities who regularly teleworked before the abrupt shift to pervasive teleworking in response to the COVID-19 pandemic, they reflected on how their perspective differed from their colleagues

who suddenly started fully teleworking from home, which was new to many of them. All of these comments happen to be from people who are BLV:

*I don't want to be isolated, but I don't feel isolated as much I think as they do. And I don't know if that's because I can't see and just talking to somebody is very similar for me on the phone as opposed to in person. P1*

*When it's just two of us on a Teams call with 18 people in the room, the telecommunications issues, they don't feel them. P1*

*I think people are sort of panicking to show they're productive or something, maybe, working from home versus if you've been doing it for a long time... You know you're productive, and you've got this thing down and you know what you need to do. P23*

*Many of my colleagues, this is the first time they're doing it, so I was actually viewed as a bit of an expert and some of my suggestions or insights for newbies at telework were actually sought, which I was delighted to share P25*

P1 pointed out that since he could not see his colleagues, interacting with them remotely over video calling did not seem much different than in person. However, he hoped that his colleagues would develop more empathy with remote work concerns, now that they were experiencing it first-hand. P23 and P25 explained how their prior experience with telework was useful in helping their colleagues adjust to teleworking.

Several participants would like to telework more frequently, but were limited by company policy or manager preferences:

*Sometimes management, they really feel like you just gotta go out there and face time with your customer all the time and really be in front of them. P21 (Neurodiverse)*

*[only teleworking 1 day a week, because the manager] He prefers the option to be able to swing in when he wants. P20 (Neurodiverse)*

*The inclusion, in terms of like having a disability, is still a bit of a challenge because I don't feel that a lot of managers understand things and understand disabilities when they're planning or thinking of something. P23(BLV)*

*I have to remind myself, I have to be as good at this as I possibly can, because I'm so thankful for the opportunity that I don't want to blow it. I want to do 120% all the time, every time. I will outwork everybody on the team... I just want to be so productive that nobody asks, nobody bats an eye when it comes to, 'Why does this guy work remotely again?' P4 (BLV)*

While technology enables and supports teleworking, these comments illustrate how its use is importantly governed by a level of management discretion and policy. P4's comment illustrates how people who telework were historically viewed as an unusual exception that could attract unwanted scrutiny on their work performance. While this study focused more on how people interacted with the technology of telework, how that technology is deployed in the workplace is also an important factor.

## 5 DISCUSSION AND DESIGN IMPLICATIONS

The interviews of people with disabilities provided a different perspective on telework, which became a very pervasive work experience in response to the COVID-19 pandemic that is likely to remain important in future work experiences. While people with disabilities may have been early to embrace telework as a way of accommodating their diverse abilities, their experiences may help

all of us become more effective in teleworking. The study confirms that people with disabilities see many benefits of being able to telework [3, 14] and unpacks details of how those benefits differ depending on the user's abilities and work context in today's work environment.

While several issues arose with specific disabilities and activities, an overall theme that emerged from these observations that goes beyond prior research is how the digital representations of people with disabilities afforded by telework technologies affected their online meeting activity. These representational aspects are described along with some design implications that can help telework tools better support our work. Finally, some limitations of this study are acknowledged, as a way to encourage future work.

## 5.1 Digital Representations in Telework

Investigating the telework practices of people with disabilities identified some subtle but important ways in which telework technologies can affect their digital representations in online meeting activity. Participants commented on how these representations affected how engaged they were perceived to be in the meetings when they turned off video or muted audio, how visible they were when they spoke through accessibility resources like ASL interpreters, and how screen sharing potentially leaked out cues about their disabilities. Given how pervasive teleworking has become, it is increasingly important that teleworking tools enable users to manage the impressions people form of them when using those tools.

*5.1.1 Representation when turning off video or audio.* Participants described several reasons for choosing to not share video or mute audio. People who are BLV often did not turn on their video, since they were unable to make use of the video channel and did not want to share a visual signal that was inappropriate (because they were unaware if they were properly framed or what could be in view of the video). People who are neurodiverse managed how much they would turn the video camera on, since that required cognitive effort to maintain eye contact and convey appropriate social signals. A person with Tourette's described muting her audio to avoid sharing phonic tics with other meeting participants. These observations indicate that people with disabilities appreciated the control and choice of how they are represented in online media that enabled them to manage the presentation of their diverse abilities in telework activities.

However, changes precipitated by the sudden shift to telework due to the COVID-19 pandemic have also changed the dynamics of intentionally withholding the sharing of video and audio. Participants reported that their colleagues implicitly expected everyone to turn on their video to compensate for their lack of being physically together in the office. Interview participants indicated that they were turning on their video, despite going against their personal preference. It is as if not turning on your video during this situation would draw more attention to being different, which is often an underlying concern for this user population.

Especially during this season of pervasive telework when the social expectation tends toward wanting a richer, higher fidelity connection with colleagues, how people are represented when they turn off their camera can affect how engaged they appear in the meeting. Most video calling tools represent participants with no video as a blank video window with a name label and a static profile picture if one was uploaded into the tool or the user's initials for people not identified by the system or even a generic icon for those calling in via the phone, as shown in Figure 2. Especially compared to the live video feeds of other meeting participants, these static representations may be interpreted as demonstrating less engagement with the meeting. P8, who has dyslexia, proposed an alternative:

*I would love is if there weren't a static picture of you that comes up when you're not on video... if there's something more dynamic that could be done for people who either can't be on video or, in my case, like are not as comfortable 100% of the time being on video, that would be awesome.*



Figure 2: Typical representations of people in a video call who are not sharing video, such as a static profile picture (top right) or initials for those without a profile picture, or phone icon for those calling in (bottom).

The design space could be explored for providing more dynamic, engaging alternatives to the static icons currently shown when users do not share their video or connect by phone. Dynamic representations of sound, such as the audio signals often displayed on audio equipment or when playing sound recordings on TV, could provide more sense of engagement without sharing video. Or sensor-driven avatars (such as Avatar Kinect [15]) could provide some of the expressiveness of video without revealing all of the details. While the issue of choosing whether digital avatars in virtual worlds reflect people's disabilities has been identified in prior work [10], this observation shows how more common digital representations can also affect how people with disabilities are perceived in online interactions.

Participants with motor or phonic tics mentioned turning off video or muting audio to suppress sharing those tics with their meeting participants. This issue could be addressed using AI to filter out phonic tics from the audio stream or motor tics from the video stream. Just as AI is being used to suppress background noise in the audio (e.g., dogs barking) or replace the visual background with a virtual one, it could also be used to filter out transmitting phonic and motor tics in meetings. Tics tend to comprise a limited repertoire of consistent behaviors that an AI could be trained to recognize and filter out of the streams. This filtering could relieve the user of suppressing the tics and enable them to demonstrate more engagement through their audio and video participation in the meeting.

*5.1.2 Representation when speaking through an interpreter.* Furthermore, people who are DHH described how they would never be seen in video calls that switch video views based on the current active speaker, since their speech through ASL was silent. When their ASL interpreter spoke on their behalf, it was their interpreter's video stream or icon that visually appeared, not

their own. People who are DHH found themselves to be invisible in online meetings due to the design choices made by some telework tools.

This supportive relationship suggests the role of a delegate participant, who speaks on behalf of a meeting participant, and should be represented differently than a typical meeting participant. For example, when an ASL interpreter speaks on behalf of a person who is DHH, the deaf person's video should show up as speaker activated, rather than the interpreter's. In fact, the interpreter should not appear in a video tile of their own at all to the other meeting participants, but does need full access to their videos and screen sharing. However, delegate participants need a dedicated, focused connection with the person they are supporting, so they can share a continuous and uninterrupted view. Delegate participants may show up more as a role (e.g., Jane's ASL interpreter) rather than a username, which could also provide more flexibility when meetings are rescheduled during a different interpreter's work shift. Delegates may also not be included in non-scheduling communication with the meeting participants, such as when a meeting attendee list is used to follow-up via email on topics generated from the meeting.

Besides people who are DHH, delegate participants could be useful in other use cases, such as people who use a foreign language translator. A variation on the idea could help people who are non-verbal or choose to communicate via text rather than speaking by having their video windows appear when they contribute their text, so that their participation is more visible.

*5.1.3 Representation when screen sharing.* Beyond audio and video, screen sharing and collaborative editing provides additional opportunities for "leakage" of cues around diverse abilities. One concern raised is how screen sharing can incidentally reveal the user's accessibility customizations. Since screen sharing takes the user's screen and reproduces the display pixels on all the other meeting participants' screens, it can reveal if the user is magnifying their screen or inverting the colors for higher contrast to help them see better. This representation is not only unfamiliar to many viewers, but also potentially discloses the user's visual limitations, which might not be something they wanted to disclose. Instead, perhaps accessibility customizations could only be applied locally to the user's display, but an unmodified screen could be shared with all other meeting participants. Cursor pointing and other interactions with the screen would need to be scaled appropriately to register correctly on everyone's screens. But screen sharing should enable sharing visual common ground without literally having to share the pixels of the user's screen, which may have magnification and color inversion applied for greater visibility.

Similarly, taking more time to accomplish activities while controlling a shared screen or collaboratively editing in view of others may reveal different work practices which may not have been previously apparent and lead others to make inappropriate inferences about their performance ability. These concerns are fundamentally based on the impression management work that Goffman articulated [13], and the need to maintain control of how to transition from backstage to frontstage activities. Participants described avoiding certain kinds of collaborative activities, especially if they could end up disclosing or drawing attention to their diverse abilities. However, choosing to refrain from these activities could also lead to unwarranted inferences about their lack of engagement in the collaboration.

The interviews identified how people with disabilities were concerned about how their representation through telework technologies might reveal their disability in ways that they would not want to disclose. While visibility and disclosure of disability in the physical world has also shown up in social virtual worlds [10], considering these issues in online telework tools also needs attention. Studying "extreme" users of people with disabilities helped identify some of the

subtle implications of these representational design choices that can help make teleworking more satisfying and comfortable for everyone.

## 5.2 Limitations of the Study

While the interviews included a reasonable diversity among types of disability and gender, the 25 participants cannot cover the broad range of abilities among this user population. As is typical for this population, recruiting participants was a challenge, especially including beyond people who are BLV. While some common themes emerged, there was not enough data to reach saturation, and new insights were continuing to emerge throughout the interviews. Since all participants were from the United States, the study cannot address cultural factors in other countries that can play a major role in work practices.

Furthermore, since the original recruitment was among people with disabilities that already regularly teleworked, there is a self-selecting bias towards job roles that lend themselves to telework and people who had ready access to internet technologies and took the initiative to establish that work practice. This study represents the perspectives of people who had made telework successful for them, while those that had more challenging telework experiences could have different perspectives. Furthermore, during the pandemic response, the working world scrambled to try to enable telework for all kinds of job roles, and employees had to figure out how to make it work regardless of their personal preferences. Understanding the telework experiences of people with a wider range of motivational and contextual factors, including those with no prior telework experience, would provide even broader insights into teleworking.

While the study identifies overview issues across disabilities, further work could be done to focus more deeply on any of the user groups. Furthermore, none of the stories elicited in the interviews commented on interactions among multiple people with different disabilities, which can involve accommodations that can conflict among the differing needs. Also, all interview participants lived and worked in the United States, and since work practices are influenced by cultural norms, it would be important to understand any differences in other cultures. None of the participants were younger than 28 years old, and since practices around using technology can be sensitive to age, it would be especially interesting to explore how younger people interact with telework technologies. With the shift to online learning in light of the pandemic response, a focus on the use of telelearning technologies among an educational demographic would be very timely.

Since technologies to support work are constantly developing, it is important to continue to investigate how the telework practices of people with disabilities develop over time. Especially as the world works through a pivotal change in work practices in light of the long-term response to the COVID-19 pandemic, telework is likely to play a more important role in future work practices. The interviews were conducted within the first month of closing down office buildings in the United States, so represent a snapshot of perceptions while the working world was still adjusting to a sudden shift to telework.

## 6 CONCLUSIONS

Interviews of people with disabilities identified concerns with the telework user experience, especially after the COVID-19 pandemic response made remote telework more pervasive. The design of mediating technology involves many choices that affect how participants are digitally represented in their online interactions. While the technology designers make those choices, the implications of them are cast on the end user participants. People who turn off their video in a video call, and represented as a static blank rectangle with their name or perhaps a profile picture,

may be considered to be less engaged in the meeting because of that design choice. Prioritizing the video windows of those who speak during a meeting, may cause users who do not speak (especially if they are speaking through an interpreter) to be rendered invisible in meetings. Using accessibility as a magnifying lens to examine how telework technologies are used by people with disabilities made it easier to see these subtle design issues. While many of those choices are governed by limitations of the technology, it is important to carefully think about the implications of those choices on the end users, and reconsider them as new technology becomes available.

People with disabilities embraced the flexibility and higher degree of control of their work environment that telework affords. People with different abilities voiced different preferences about sharing video and using accessibility features, and appreciated the flexibility of being able to customize their telework experience for their needs. However, several participants reported that their frequency of telework was limited by management policy. With telework becoming part of the post-pandemic “new reality”, that concern may be lifting. Previously, being the only person connecting remotely to a conference room of meeting participants created a social representation of being different with a need to justify that difference. With teleworking becoming more pervasive, their previously conspicuous role as a remote worker has now become socially leveled, with more participants connecting remotely.

This research identifies both digital and social representation concerns that affect the user experience of telework for people with disabilities. The interviews identified how the design of people’s digital representation through telework tools can affect the perception of how engaged people with disabilities are in meetings. Participants also mentioned social factors that limited their use of telework technology in a work setting. Both digital and social representation issues need to be addressed to enable people with disabilities to fully leverage the greater flexibility and control that teleworking provides over their work environment.

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## APPENDIX

The following interview guide was used, which builds on a subset of their responses to the online survey which used a similar structure. During the semi-structured interview, we were able to explore beyond these specific questions.

1. How do you typically interact with your collaborators when you telework?
2. Regarding real-time screen sharing, can you tell me more about the most recent example when you used or were unable to use screen sharing?
  - a. What was the context: how many people, what collaboration tool, who wanted to share screen? Was it a presentation or more of an interactive working meeting?
  - b. What was the content about?
  - c. What worked about screen sharing?
    - i. Was any assistive technology involved in the screen sharing?
  - d. What was challenging about screen sharing?
    - i. Is there anything specific to your abilities that makes screen sharing challenging?
3. Are there other memorable or interesting examples of attempts to use screen sharing that you could describe?
4. Regarding collaborative editing tools, can you tell me more about the most recent example when you used or were unable to use collaborative editing tools?
  - a. What was the context: how many people were involved, what collaborative editing tool, who initiated the collaborative editing file?
  - b. What was the content about?
  - c. What worked with collaborative editing?
  - d. Was any assistive technology involved in the collaborative editing?
  - e. What was challenging about collaborative editing?
  - f. Is there anything specific to your abilities that makes collaborative editing challenging?
5. Are there other memorable or interesting examples of attempts to use collaborative editing that you could describe?
6. Let's talk some more about the things you mentioned as barriers to your productivity and social inclusion while teleworking. You said [...] Can you give me some examples of that?
7. How did you initiate teleworking on your job?
8. Has anything changed in your telework experience with the recent company initiatives for people to work from home in response to the COVID-19 (new coronavirus) outbreak?
  - a. Has the amount of online meetings increased or the number of other people joining online increased?
  - b. Are there any differences in online meetings because more people are attending remotely, instead of just you?

- c. Are your colleagues getting new or more experiences joining online meetings when they are remote? Has that prompted any changes in the overall online meeting experience?
  - d. Are there any changes in collaborating with your team you wish would continue after the COVID-19 outbreak has subsided?
9. How could teleworking be improved for you (e.g., equipment, future technology, processes, support)

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