

Collaborative Accessibility: How Blind and Sighted Companions Co-Create Accessible Home Spaces

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ABSTRACT

In recent decades, great technological strides have been made toward enabling people who are blind to live independent, successful lives. However, there has been relatively little progress towards understanding the social, collaborative needs of this population, particularly in the domestic setting. We conducted semi-structured interviews in the homes of 10 pairs of close companions in which one partner was blind and one was not. We found that partners engaged in *collaborative accessibility* by taking active roles in co-creating an accessible environment. Due to their different visual abilities, however, partners sometimes encountered difficulties managing divergent needs and engaging in shared experiences. We describe outstanding challenges to creating accessible shared home spaces and outline new research and technology opportunities for supporting collaborative accessibility in the home.

Author Keywords

Accessibility; Blindness; Vision Impairment; Collaboration; Interpersonal Relationships; Home

ACM Classification Keywords

K.4.2 [Computers and Society]: Social issues - *Assistive technologies for persons with disabilities*

General Terms

Design, Human Factors.

INTRODUCTION

Visual disability affects many aspects of a person's life, limiting access to education, employment, independent navigation, online communication, and much more. Nearly 285 million people worldwide [39] and 2.2% (6.8 million people) in the US [9] have a visual disability.

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Many people with vision impairments value leading independent lives. Accordingly, the primary objective of accessible technology research and development has thus far been to provide users with devices that enable them to act independently in their home and work environments [30, 38]. This perspective is appropriate when activities are carried out individually, but may not serve in collaborative settings, particularly in mixed-ability groups. Indeed, most blind people live with others [41] and often live with people who have a different level of visual ability. This raises questions as to whether accessible technologies support or hinder social activities and whether they can simultaneously accommodate people with different abilities.

To explore how accessibility is created and managed in a shared environment, we spoke with 10 pairs of companions (one blind person and one sighted person) about their activities in the home. Through contextualized, semi-structured interviews, we identified accessibility challenges and workarounds. We found that both members of the pair worked to co-create an accessible household—we call this *collaborative accessibility*—through the joint activities of preparation and intervention. We also found that inaccessibility caused conflicts and made it difficult to maintain an equal and healthy relationship. We conclude by identifying opportunities for future work around the following three insights: some accessibility problems are pernicious, while others may be beneficial; accessibility is co-constructed and in constant flux, depending crucially on social context; and accessibility and relational wellbeing are intertwined, often competing interests.

RELATED WORK

This work sits at the intersection of two flourishing areas of research: the study of technologies for the home and the study of accessible technologies for blind people. Our work contributes to a small and growing literature that explores collaboration between people with diverse abilities.

Collaboration in the Home

Much research in CSCW has explored the home as a place to coordinate family efforts. This includes studies that have observed how roles [28], routines [7], technology resources [5], and errands [33] are managed in the home. Our research continues in this tradition by examining how work

is individually and collaboratively achieved by intimate partners, roommates, and close friends.

Because coordinating activities is an important part of being a family [21], there has also been substantial research related to home calendaring systems [8,21]. Plaisant et al. [26] explored a calendaring system for remote families that was accessible to older adults. Thayer et al. studied how adults without children [34] and partners in intimate relationships [35] share calendars to coordinate activities in and outside the home. Though most calendaring research has focused on "life scheduling," Thayer et al. [34] propose a focus on "relationship work" achieved via coordination. Similarly, we explore collaborative home management and how it can affect adult relationships.

Other researchers have also looked beyond "work" to consider the home as a place to nurture connection and intimacy. Although this area of study has predominately sought to create connections between *remote* households [12,20], some recent work has considered how *collocated* family members and intimate partners communicate and connect in the domestic space [4,36]. This line of research increasingly considers families and relationships that have been traditionally marginalized or overlooked [17,19].

Like previous research, we consider resources, roles, routines, and responsibility sharing among housemates, as well as their effects on intimate relationships. Our research is set apart by a focus on the specific challenges presented when partners with different visual abilities work together.

Accessible Technology for Blind People

A common strategy for creating user interfaces for blind people is to translate visual information, such as graphics or written text, into another modality, such as speech or tactile feedback [14]. Electronic information is primarily accessed through screen reader software, which converts graphical on-screen information to synthesized speech or Braille [14].

Advances in mobile technology have made it possible for blind people to gather real-time feedback about their immediate environment that was not previously accessible. For example, mobile software may be used to provide navigation directions (e.g., [40]) or to answer questions about visual surroundings (e.g., [2]).

Even when technology is available to solve a given accessibility problem, users may choose not to use it [23]. Shinohara and Wobbrock [32] explored how users' perceptions of stigma, or negative attention from others, affected when or if they would choose to use accessible devices in public settings. Kane et al. [10] explored how individuals chose and used accessible technology outside the home and found that they considered both social perceptions and functional aspects. These studies primarily considered reactions from strangers, while we explore how an individual's accessibility choices may affect their friends and family.

Collaborating Across Different Abilities

When using a computer, many blind people run screen reader software to convert on-screen content into spoken text. Over time, screen reader users can become quite proficient, listening to spoken content at a much faster rate than non-expert users can understand [3]. We suspect this may make it difficult for blind and sighted collaborators to gain equal access to content in collocated sessions.

Several research projects have explored prototypes that provide information access to both blind and sighted users via dual-mode graphical and audio interfaces [27,29]. Similarly, prototypes of games that can be fairly played by blind and sighted users via dual-mode interfaces have been developed [27,37]. Piper and her colleagues have investigated the use of computing tools to enable communication between deaf and hearing partners [24] and between older adults and family members [25]. Other research has shown how building empathy between a person with a disability and a partner can help them understand each other and work better together [10,13].

In this study, we examine relationships between pairs of people with varying visual abilities and how they negotiate mutual access in a shared home environment.

FIELD STUDY

Participants

To explore the accessibility issues that arise in the social setting of a home, we conducted contextualized interviews with close or cohabiting pairs. We interviewed 10 pairs of participants (Table 1) in sessions lasting two hours. Each pair was comprised of one sighted and one blind or low vision participant. All participants used screen readers. All but one pair of participants were cohabiting, and eight pairs were partners in an intimate relationship. Participants were recruited through local disability social groups, previous study contact lists, as well as through snowball sampling. Participants were compensated for their time.

Procedure

Interviews were conducted in the home of the blind participant, with the exception of two pairs, who were interviewed over a Skype video connection. Both partners were present throughout the interview. Interviews were semi-structured. Most interviews included a tour of the home, in which participants showcased accessible and inaccessible housewares and demonstrated activities of daily living. One Skype interview took place in-home, but the other did not. In the latter case, participants shared pictures of their home after the interview.

We asked participants about their relationship and visual abilities. Core questions revolved around how they accomplished work in the home, particularly how they performed activities together or individually. Although we asked questions about the home, conversations sometimes branched out to include external activities like grocery shopping, movie-going, and walks in the neighborhood.

Analysis

The interviewer took detailed handwritten notes during interviews and home walk-throughs. After the interview, she expanded notes and performed initial coding by penning incident-by-incident themes overtop of these notes (as described by Charmaz [6]). Incidents and their initial codes were discussed between researchers and collaboratively synthesized into higher-level themes through focused coding [6]. During this process, low-level initial codes were gathered into focused codes. Codes were iteratively refined to more accurately reflect participants' own values and language. In a final review of the audio and video recordings as well as the photographs, the interviewer transcribed incidents that illustrated the codes and identified any remaining themes that were not previously captured. Conceptual categories presented in this paper represent the fundamental and recurring themes of the coding process. In reporting below, we use the capital letter 'S' to identify sighted participants (e.g., Ava (S)).

FINDINGS

We found, contrary to predominant philosophies [30, 38], that accessible technologies are often used in collaborative contexts, and maintaining an accessible space required collaborative work. Hence, in this paper, we use the term *collaborative accessibility* to refer to situations in which family members, friends, acquaintances, or strangers help (or hinder) accessibility. After a brief introduction to the basic tenets of home accessibility, we explore examples of collaborative accessibility with respect to three aspects: 1) patterns of collaboration, 2) challenges of collaboration, and 3) demands on interpersonal relationships.

Making the Home Accessible

While the main focus of our investigation was how blind and sighted people work together in the home, participants told us about the inaccessible aspects of their homes and how they used technology to address these challenges.

Not surprisingly, the major challenge to making the home accessible are the numerous items that can only be distinguished visually, such as paper mail, food containers, clothing, and appliances. Blind participants sometimes relied on their sighted partners to describe these items or added tactile adhesive "dots" or Braille labels to flat surfaces (Figure 1).



Figure 1. Dots and Braille labels were used, sometimes in combination, to augment appliances. Some (Jasmine, left) used dots more liberally than others (Robin, right).

Participants also used computing technology to make their homes more accessible. All of our blind participants used screen reader software to access a computer; Ian used a combination of a screen reader and screen magnification software. Eight of our participants had a smartphone, and used applications such as TapTapSee, CamFind, and

Participant	Relation	Cohabit?	Age	Career	Visual ability
Parsa	married, 8 years	yes	36	Grad Student, Software Engineering	blind, gradual loss since birth due to RP
Ava			32	Grad Student, Computer Engineering	sighted, needs glasses when driving
Kay	married, 16 years	yes	49	Rehabilitation Teacher	blind since birth due to LCA
Phil			51	Bus Driver	nearsighted with astigmatism, corrected with glasses
Jasmine	roomies, 6 months	yes	29	Attorney	blind due to premature birth
Dhanvi			26	Attorney	sighted, had Lasik eye surgery
Butterfly	friends, 8 years	no	32	Nonprofit Manager	blind, born sighted, woke up blind in late-teens
Henri			63	Retired IT Manager, Volunteer	sighted, no correction needed
Lisa	dating, 4 years	yes	58	Program Management Analyst	blind, vision loss since early teens due to Glaucoma
James			48	Assistive Tech. Teacher	sighted, wears bifocals at all times
Guido	married, 28 years	yes	60	Retired Database Manager	blind, lost vision gradually due to RP
Jean Marie			56	Elementary School Teacher	nearsighted, astigmatism and presbyopia (corrected)
Ian	married, 41 years	yes	70	Retired Economist, Artist	low vision, diagnosed with Glaucoma 30 years ago
Brynn			63	Healthcare Consultant	sighted, wears reading glasses
Bear	married, 41 years	yes	67	Rehabilitation Teacher	blind in one eye since birth, lost all sight as pre-teen
Sissy			63	Convenience Store Staff	sighted, wears glasses
Rebecca	dating, 3 years	yes	22	Social Worker	blind since 3 years old due to Microphthalmia
Mitch		yes	26	Software Engineer	sighted, no correction needed
Robin	married, 8 years	yes	31	Homemaker	blind since birth due to LCA
Ben	8 years	yes	37	Entrepreneur in IT	sighted, corrected with glasses

Table 1: Summary of study participants. Participants provided their own pseudonyms.

VizWiz [2] for reading print materials, along with ColorID and iBill for detecting colors and currency denominations.

Finally, some participants had devices designed specifically for use by blind people, such as talking clocks. One participant used a water level sensor that announced when a cup was full of liquid, and two participants used the RNIB PenFriend audio labeller to identify pill bottles and CD collections. BrailleNotes, portable computers with refreshable Braille displays, were also prevalent.

Patterns of Collaborative Accessibility

Inaccessibility often resulted in sighted partners providing support and guidance for their blind partner. Some tasks could be completed independently if the pair *prepared* by configuring the environment in a predictable way, or practiced the steps of a task so they could be committed to memory. Other tasks could not be performed independently, no matter how often the blind participant practiced; these tasks required *intervention*. One participant, Parsa, sorted these into activities “I can do” and activities “I can’t do,” respectively. The latter were perceived as interruptive and frustrating to both partners. Parsa explained: “it is very irritating to have to interrupt someone to ask them to help me perform one step of the whole.”

As we see in future sections, the burden of assisting by intervention as opposed to preparation is significant, not only for the sake of one’s independence, but also for the sake of healthy relationships. Accordingly, we classify the basic collaborative accessibility formats we observed into the following two categories: *preparing for a task “I can do”* and *intervening in a task “I can’t do.”*

Preparing for a task “I can do”

Many activities in the home are independently accessible if and only if a degree of preparation has taken place, often with the help of a sighted companion:

[Jasmine]: [Being blind], you learn how to plan things. You can’t just do things on the spur of the moment. Stay organized and plan.

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[Guido]: I kind of compare it to when you go to the circus and you watch these people on the flying trapeze. All you do is see what they’ve done, you don’t see all the practice, and you can’t do that without practicing. I can’t, pretty much, go most places without practicing.

We found that preparation took place in two different forms, *staging* and *rehearsing*, as described below.

Staging. One form of preparation involves setting up the physical environment—either permanently or for a shorter duration—in order to enable more independent activity in the future. Staging includes working together to place adhesive tactile markers on items throughout the home, like stovetop dials and flat screen dishwasher buttons. It also includes spatially organizing everything—kitchen utensils, foodstuffs, clothes, power tools, etc.—and maintaining that organization so the blind partner can memorize locations

for future access. We even found cases of “outsourcing” organization, as when Lisa and James hired a professional to find a place for everything from the kitchen plates to the tweezers.

Whereas tactile dots and home organization schemes were more permanent fixtures, participants also engaged in daily and weekly staging rituals. Every week, Dhanvi (S) helps Jasmine match five outfits and hangs them sequentially in her closet, so that she may dress efficiently and independently each morning. When Parsa used to have more time on his hands to cook, he would ask Ava (S) to prepare by arraying necessary ingredients on the counter:

[Parsa]: I would ask her in the morning ‘I need this, this, this, this, and this. Please put them out near the stove so that when I arrive home, I can find easily the spices and other stuff I needed...’ Because I want to be fast enough.

As a final example, Jean Marie (S) has developed a second folding technique to help Guido distinguish between casual t-shirts and dress shirts based on their feel. Now, Guido can dress independently instead of having to ask Jean Marie (S) to identify an appropriate shirt each morning.

Rehearsing. Sighted participants also guided their blind partners through inaccessible interfaces and environments so that they might eventually commit them to memory. For example, Butterfly’s digital video recorder, TiVo, is not accessible. Yet, Butterfly is able to use her TiVo because she memorized the menus with sighted help:

[Butterfly]: My father just went through the [TiVo] menus with me [when he visited my house]... I’m not able to do all of it, but am I able to pull up my soap opera? Sure.

Rehearsing may include describing buttons, dials, and menus on an interface or reading through instructions in preparation for the blind partner to use these independently. When Jasmine purchases new clothes, she asks Dhanvi (S) to read her the washing instructions, which she memorizes to do laundry independently. Phil (S) applied dots to the microwave for Kay and walked her through each dot and its function by guiding her hand. He then watched her practice heating a cup of water to test her understanding.

Both blind and sighted participants sometimes performed rehearsing individually to lessen the burden on the sighted partner during more real-time intervention activities (described in the next section). For example, Parsa used to read the script of “Lost” TV episodes before watching the show with Ava (S) so that he could follow the plot more independently. And, Ava (S) sometimes watches a new movie by herself before seeing it with Parsa so that she can more easily explain the plot to him as the movie plays.

Intervening in a task “I can’t do”

In contrast to the preparation tasks described above, in which early planning could enable the blind participant to perform tasks independently later, some collaborative tasks required an intervention from the sighted partner each time

that task was performed. These tasks ranged from answering quick questions to carrying out activities with, or in place of, the blind partner. In many cases, interventions are simple and brief, yet cannot be planned for or worked around. Participants experienced this as becoming "stuck" or having "an emergency" and therefore found this type of inaccessibility most frustrating.

Spot-checking. Participants identified tasks that are largely accessible and can be performed independently, but require a sighted person to "double check" their work. This included checking their cleaning or their outfits:

[Butterfly]: Double check—and that's a lot of what I have [Henri (S)] do. Double check me on stuff. 'Did I miss a spot [cleaning]?' 'Does this [shirt] look alright?'

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[Lisa]: In the mornings... usually I'll have to ask [James (S)] if I look all right before I leave [for work].

Requesting task assists. While spot-checks are interventions that usually take place at the end of a task, task assists may occur in the middle of a task or constitute the entire task. For example, Jasmine needs Dhanvi (S) to help her deposit checks on her phone, because taking the picture, signing the check, and writing the deposit amount are all inaccessible to her. Jasmine opens her banking app and logs into her account before passing the phone to Dhanvi (S) to do the rest. Similarly, Guido, must ask Jean Marie (S) to turn down their inaccessible touchscreen thermostat every morning.

When a collocated sighted person is not available, some participants use video chat to connect with remote family members or friends for task assists:

[Jasmine]: If I can't figure something out, I'll ask [Dhanvi (S)]. If she's not home, I usually try to get someone on Skype or FaceTime—my mom or something—to tell me what it is.

While most of the cases of requesting task assists involved the sighted person assisting the blind person, we encountered several examples of reciprocal support. For example, Parsa stated that he is really good at finding quality clothing, so Ava (S) always takes him shopping with her. Guido has a great sense of direction and is the designated navigator in his family.

Real-time narrating. Some activities were performed side-by-side in the form of narration. For example, when Butterfly wants to clean out her TiVo queue or sort through her medicine cabinet, Henri (S) will assist by reading labels throughout the process. Ava (S) describes the visual parts of the television program as she and Parsa are watching a show. As noted above, Ava (S) sometimes watches the show alone before watching it with Parsa, showcasing how both *preparation* and *intervention* may be necessary to carry out a task effectively.

Challenges to Collaborative Accessibility

In the previous section, we demonstrated how collaboration between blind and sighted partners is a key strategy for making the home accessible. Now, we turn to various challenges of collaborating. Challenges are presented across three themes: organization techniques, technologies, and social settings.

Clashing organization preferences. Spatial organization is a key aspect of making the home accessible. Most participants fastidiously organize their homes—the furniture, the items on countertops and shelves and in cabinets—such that everything has a regular, memorized location. In Butterfly's words, "you have to have a system, or your stuff is always lost, misplaced." We noticed, however, that sighted people can use their vision to scan for out-of-place items, making them less reliant on perfect organization. Accordingly, we found that sighted housemates sometimes undermined organization schemes if they were unaware of, forgot about, or were not persuaded by how important organization is to blind partners. Due to partners' different abilities and needs, effective spatial organization required collaboration and time to habituate:

[Lisa]: [James is] actually very good at—I mean, my daughter, even after living with me for a lifetime, sometimes puts things back in the wrong place. That's one thing that blind people tend to do is have places for everything. It's taken four years of living together [with James]... If our dishwasher is locked, it means the dishes are clean. We have these signals to each other.

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[Interviewer (S)]: Do you store things in any particular order in [the kitchen]?

[Phil (S)]: I think [Kay] would like to, but then she's got to live with me, and I never think to put something back in the same spot twice.

We can think of these breakdowns around organization as breakdowns in the *staging* process. When housemates do not work together to keep the house accessible, it can be difficult for the blind participant to carry out activities independently and feel in control:

[Kay]: I would like to vacuum, but sometimes there's stuff on the floor, so it's hard for me. Because I've broken vacuum cleaners... It's harder when we have other people that leave things lying around. ... I wish I could vacuum. But, if I say something, someone will just do it for me. It's hard; I feel a little bit out of control with that.

One way that participants addressed the problem of maintaining an organized home was to develop shared protocols to reinforce *staging* behavior. For example, Mitch and Rebecca created a mnemonic for remembering how to differentiate the shampoo from conditioner in the shower:

[Mitch (S)]: Now and then we'll think of a mnemonic, like 'the shampoo goes down, the conditioner goes up.'

[Rebecca]: Like, the lid. Because the bottles look the same, so the lid.

[Mitch (S)]: So, I remember CU, which is a university, Colorado University.

[Interviewer (S)]: Yeah, 'Conditioner Up.'

[Mitch (S)]: Yeah, 'Conditioner Up.'

Another solution was to periodically solicit help from other family members (e.g., Kay's daughter), volunteers, and even professionals:

[Lisa]: We do have a place for everything. And, a friend of ours is a professional organizer, so... our cabinets are very organized. She not only helped me, she has helped [seven of our friends]. What she specializes in is people with all disabilities... She's excellent... She helped us in a bunch of different ways to find better methods of living together as a person who's blind and one who has ADHD.

These home organization strategies showcase how partners' different needs and behaviors, stemming from visual abilities and otherwise, required explicit acknowledgement and collaborative workarounds to support accessibility for the blind participant.

Difficulties sharing accessible technology. Accessible technologies, like adhesive tactile dots, Braille labels, BrailleNote computers, or screen reading software, were used in the home to support access. In some cases, the accessible technology needs of blind partners conflicted with needs of sighted partners; compromise often resulted in decreased accessibility. Tactile labels, for example, inconvenienced some sighted partners by obscuring underlying visual labels. To this point, Kay decided to use clear as opposed to opaque dots; this compromise makes the microwave accessible to both Kay and Phil (S). However, Bear decided to take the clear Braille labels *off* of his microwave because his sighted family members found the augmented touchpad difficult to use. Here, we see how accessible reconfigurations do not always work because they do not address the needs of everyone in the house.

Furthermore, accessible interfaces sometimes proved to be difficult to use in collaboration with a sighted partner. Accessible devices were most effective when used by blind individuals alone rather than collaboratively, such that participants had to make special adjustments or avoid certain activities altogether. partners often used media in dedicated accessible formats: audio described movies, BrailleNote games like Hangman, or audio-only games. Rebecca, likes to play accessible games online with friends who are also blind using RS Games (rsgames.org), The Playroom (qcsalon.net), and All In Play (allinplay.com). Some formats, like audio books on Audible.com, were used and enjoyed by both partners, but more often, we found that accessible media was difficult to share, or was not entertaining for sighted housemates:

[Jasmine]: If [a movie has] audio description, it annoys the sighted people.

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[Mitch (S)]: We've kind of thought and talked about finding games that we can play together. We did once. She plays Monopoly on RS Games She plays that a lot and I played it once with her and her friends.

[Rebecca]: But, I mean, that doesn't have the visual [interface], so that's kind of annoying...

[Mitch (S)]: The visual wasn't the problem, it was just the speed that they played it at.

As we see in the example of Mitch and Rebecca above, the result of separate interfaces for blind and sighted is that users develop different skill sets; accordingly, Rebecca and her friends are able to play the game at a pace that is disorienting for Mitch, because he is used to relying on visual cues to make sense of the state of the game.

As a workaround, participants often sacrificed accessibility by using a device that is only accessible or usable for one partner. In these scenarios, the sighted partner would perform *real-time narration* to describe some aspects of the visual interface. When Ben (S) and Robin play Monopoly on the iPad, instead of using VoiceOver, they use what he jokingly termed "HusbandOver"—that is, he describes the state of the game to Robin. As another example, Henri helps Butterfly fill PDF forms that are inaccessible. Sitting next to Henri at her computer, Butterfly begins by turning off her screen reader software so that Henri can use the computer's touch pad and standard keyboard shortcuts without interference from the screen reader. The obvious downside to this arrangement is that blind partners are no longer able to interpret the screens for themselves.

Yet another approach to managing the use of different tools was illustrated by Kay. Kay likes to cook with her sighted daughter, but some of her recipes are written in Braille. When her hands are dirty during food preparation, she cannot rely on her daughter to read the recipe for her. So, she prepares by using her Victor Reader Stream audio player to record herself reading a Braille recipe out loud. This way, she and her daughter can replay the recording as they prepare meals. This is an example of independent *staging* that allows Kay to enjoy cooking with her daughter.

Despite the use of workarounds, in many cases participants simply opt not to play games, watch movies, or enjoy other leisure activities together because the interfaces for blind and sighted users are so disjoint and differently appreciated. As we see in future sections, the lack of a unified user experience for both blind and sighted participants can actually have a profound negative effect on relationships.

Navigating outsiders' expectations. Our discussions about accessibility in the home prompted our participants to share stories about activities outside the home. Participants noted that their strategies for accessibility were sometimes mediated by the sensibilities of sighted "outsiders."

For example, adhesive tactile dots were valuable additions to inaccessible touch-screen equipment in the home, and were largely welcomed by sighted housemates (excepting

Bear's family). Most difficulties arose when equipment, like washers and dryers or exercise machinery, was located in communal areas within an apartment complex. Participants feared that others might consider the use of dots as "defacing" the equipment and remove them:

[Kay]: I think everything's touch sensitive in that laundry room here. And, so, they used to have those coin-operated washers and dryers, and if you wanted to put it on warm/warm or hot/cold, someone could show me the buttons to turn to do that. But, now everything is touch sensitive.

[Interviewer (S)]: It's sort of a step backward, isn't it?

[Kay]: It is, and like if I put Braille on it, I'd be defacing it.

[Phil (S)]: You can't prevent someone else from taking it off.

Another participant actually encountered this problem of outsiders removing tactile labels in public spaces:

[Dhanvi (S)]: At the gym, I had to help her label the gym equipment.

[Jasmine]: I had to put dots on it because they're all flat screens. They kept coming off. People kept taking them off. So yeah, those treadmills are not accessible unless you put dots on them, and they have to stay on, otherwise you have to redo it and have someone help you. Now they started leaving them on. I don't know what happened.

[Dhanvi (S)]: No, [the staff] put a sign in there.

[Jasmine]: They did, but even when they had signs, [the labels] kept coming off, and the signs were all taken down. So, I had to put signs up a couple more times with another leader... I think people finally realized that I was persistent and I kept putting them back on and kept putting the signs back up, so finally they just gave up.

In these cases, an accessibility problem in a public space that could easily have been solved with dots and *preparation* required repeated, time-intensive *intervention*.

In another example, Kay and Phil (S) enjoy watching movies together, but no longer go to the public theater because of strangers' negative reactions to Phil's narration:

[Kay]: We used to watch TV together when we first met, and he used to take me to movies and describe them to me.

[Phil (S)]: I'd take her to a movie theater, and at times when there wasn't a whole lot of talking, I'd describe what's happening, just kind of fill in a few things. But then one time, as we left, the people behind us said 'well thank you for talking through the whole entire movie!'

[Kay]: 'We didn't need all that commentary!'

As illustrated above, public spaces can undermine the types of collaborative accessibility work performed at home. Participants routinely encountered others who did not understand blindness or share the same sensibilities about what compromises are reasonable toward achieving universal access. Faced with resistance, most participants simply stopped trying to make public spaces accessible.

Balancing Accessibility and Healthy Relationships

Our investigation focused primarily on the activities and strategies that pairs used in order to co-create an accessible

environment. In the process, we encountered stories that illustrated how accessibility is often entangled with the competing goal of maintaining and supporting interpersonal relationships. We found that the work needed to resolve accessibility issues sometimes resulted in negative feelings and conflict, as well as missed opportunities for shared experiences and acts of giving. We discuss these below.

Feeling inconvenienced, feeling guilty. Most blind participants expressed the desire to be independent, but felt that was sometimes out of their control. Dependence on sighted partners, particularly for *intervention*, surfaced difficult emotions and was a recurring source of tension. Sighted partners sometimes felt that help was requested too frequently or at inconvenient times. For example, when Jasmine asks Dhanvi for help, she often interrupts Dhanvi in the middle of an important or private activity, such as a conference call for work or personal prayer.

Ben and Robin shared a recent house-hunting incident in which Ben became aggravated at Robin. Looking through inaccessible house plans, Robin wanted Ben to *narrate*, or explain details about the location of the master bedroom, how many windows were in each room, whether it had a porch, and so on. Ben explained how difficult it can be to remain patient, and suggested the need for relationship guidance for partners with different visual abilities:

[Ben]: If you have a blind spouse, then she might need you to read things... I like to think of myself as a sensitive, loving husband. Yet, I find myself getting, as I mentioned before, aggravated... Maybe [it would be good to have] a technology or a training program for spouses that will help them learn to build up their tolerance. Because they have no moral high ground, so they better learn to cope. Like, anger management... 'this is going to happen and you will be frustrated and then you will be a jerk. And, you don't want to be a jerk, so: breathing [exercises].'

Our blind participants likewise felt concerned about possible imposition. They felt "guilty" that instances of dependence are "unfair" to their significant other. At the end of our interview, Jasmine identified the crux of inaccessibility in the home as the inescapable necessity to depend on friends for access at the expense of more important relationship-building activities:

[Jasmine]: For me, [the effect of inaccessibility in the home] is more frustration. Because I don't like to ask people for help if I don't have to... I just don't want to have that dependent kind of relationship where I'm using my friends to help me when we should be focusing on the social part.

Missing out on shared experiences. As discussed in the previous section, one problem that sometimes affected partners' relationships was the lack of a unified interface for people with different visual abilities. Many participants found it difficult to watch a movie together, a favorite leisure-time activity. Mitch (S) and Rebecca want to find a game that they can play together, but felt that neither games designed for sighted players nor games designed for blind

players can suit the needs of mixed-ability play. Following our interview with Kay and Phil (S), Kay confided that she and Phil are having relationship problems specifically tied to their different abilities. She believes that she should have married someone who was also blind, and she noted that many of her blind friends share this sentiment. Two blind partners, she explained, would be able to listen to audio books together, get a cab together, go grocery shopping together. In all of these examples, disjoint needs and abilities created missed opportunities for shared experience.

Missing out on spontaneous acts of kindness. Some blind participants found it difficult to demonstrate care for their partners through acts of service or personalized gifts. For example, Guido wished that there were more things he could do around the house to lighten his wife's load:

[Guido]: I do think that, ultimately, I wish I could do more for [Jean Marie (S)], so that [Jean Marie (S)] didn't have to do as much. And, again, it's not—sometimes it's not even the huge things. It's like a lot of little things that just add up.

Parsa wished that he could have more independence and options when purchasing gifts for his wife, because online shopping is not descriptive enough to navigate without a trusted, sighted friend:

[Parsa]: In a marital relationship, there are things that you want to initiate based on your creativity, for your partner... buying a gift is a very spiritual thing you can do... maybe I can become more independent on buying [Ava (S)] personal gifts. But, it is not easy to buy whatever I want.

Ultimately, we found that inaccessibility complicated participants' efforts to achieve independence and intimacy.

DISCUSSION AND FUTURE WORK

Not all Accessibility Challenges are Created Equal

One of the most pernicious types of accessibility challenge we encountered was the tyranny of the things “I can't do,” the “little things that just add up.” These are the unwelcome fault lines that turn an accessible process into an inaccessible one, that turn a competent actor into an incompetent one. They interrupt seamless processes by requiring intervention by a sighted person. Many participants expressed becoming “stuck,” having “emergencies,” and feeling “frustrated” by the abrupt and additive qualities of these inaccessible activities.

As Parsa and Ava articulate in the following, there is great concern that these accessibility breakdowns are not simply a matter of efficiency and productivity; at stake is the deep personal feeling that one *can do* and is perceived by others as one who *can do*:

[Parsa]: I believe there is a naturalness of collaboration between couples that should be the main flavor of the research for the future. The sort of problems that we discussed today—watching movies, cooking—they all suffer... Because when they have been designed, they have not been thought of as something natural for all people.

[Ava]: [When Parsa can do an activity by himself] it gives a good sense to both of us, because [Parsa] can participate in the home chores, like me. And this way, I can feel like my husband can help me and, although my husband cannot go out independently and do shopping, he can do some sort of things in the house.

Things “I can't do” undermine the blind person's *choice* to be independent, thus undermining their *choice* to be collaborative with sighted partners in ways that are natural within the context of the activity and the relationship. To address this problem, albeit often inadequately, participants requested task assists from partners and even remote contacts via telephone and real-time video chat.

This framing motivates the types of on-demand, flexible technology solutions that can delegate task assists to strangers or contacts in extended networks, like VizWiz [2]. Furthermore, it suggests that future design efforts should consider how accessibility features address problems within the broader *social process* of day-to-day living. Designers should prioritize accessibility problems that enforce unnatural, disruptive interventions by intimate partners.

Accessibility is Co-constructed Between Partners

In disability studies and in HCI, many researchers have adopted the goal of supporting independent living for people with disabilities [18]. These researchers tend to base their approach on the premise that the designed environment plays an active role in disabling people with various abilities [18]. In this study, we have presented the complementary finding that accessibility is contingent upon the *socially constructed* practices within a household. We observed that inaccessible features became accessible when partners collaborated via staging, rehearsing, spot-checking, task assists, and real-time narrating. As described above, some of these collaborative activities were natural and valuable, and others were not. In keeping with these findings and the demands of any interpersonal relationship, we advocate the need for technologies that foster independence as well as collaboration.

Rather than emphasizing routines as relatively fixed and stable, as some previous research (e.g., [7]), we have presented examples of how accessibility work in the home is continually renegotiated. We have shown how relationship maturity, moving to a new home, acquiring new technology (like flat-screen appliances), and developing new strategies (like a new folding technique) all contribute to dynamic accessibility routines. Furthermore, we found that simply transitioning from one setting (the home) to another (a communal laundry room or a public movie theater) also affects routines. Hence, accessibility is in constant flux.

This finding suggests that studies in more naturalistic as opposed to laboratory settings, complete with social entanglements, may shed more light on the workability of novel access technologies. Longitudinal deployments may also better capture the varying accessibility offered by

design solutions over time. Finally, technologies for one environment may not suit another; more research to compare various social settings like the home, public, schools, and workplaces is needed.

Accessibility and Relational Wellbeing are Intertwined

Research and design for people with disabilities, particularly for the blind population, tends to focus on developing technologies that directly address accessibility and independence [30, 38]. However, like previous researchers in home settings, we found that routine housework is actually a form of relationship work [34] and that technical work can “reinforce social bonds” [28]. Accessibility and relational intimacy are intertwined.

Our study shows how accessibility often competes with the goal of maintaining a relationship. Furthermore, when the needs of blind and sighted partners conflicted, the result was often decreased accessibility (e.g., when Bear’s family removed Braille labels from the microwave). Inaccessible activities that require task assistance can cause relational frustration, guilt, and feelings of unfairness to one’s partner. Additionally, technologies that fail to support mixed-ability, collaborative use can create missed opportunities for shared experiences and spontaneous acts of kindness, both of which are important intimacy-building activities [12]. Like Branham et al. [4], we found that even collocated partners need help reconnecting.

We agree with Piper et al. [25] that emotional and relational wellbeing are important facets of everyday living for people with disabilities. While our observations of relational effects primarily illustrated disconnect, we saw hints that collaborative accessibility activities can also contribute to more emotional sharing, acts of service, and joint activity. It may be that some inaccessible activities (for the blind partner acting independently) are better left that way (so partners can enjoy the experience of working together). There is need for more investigation into relationship building and maintenance, with special attention to the unique challenges of those in mixed-ability relationships.

CONCLUSION

Much research has examined how technology can support a blind person’s ability to live and work more independently, taking as primary the relationship between the blind person and their technology. However, our exploration of accessibility challenges in the homes of blind people exposed how accessible technology is used within a larger social context. Accessibility is co-constructed and dynamic. Inaccessible activities can create or foil opportunities for developing intimacy in relationships. Balancing collaborative accessibility activities and maintaining a healthy relationship is a constant challenge. These findings suggest that future efforts should continue to look at social aspects of accessibility in various settings, particularly in groups of people with diverse abilities, toward designing more human-centered accessibility ecologies.

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