Examining Voice Community Use

ROBIN BREWER, SAM ANKENBAUER, and MANAHIL HASHMI, University of Michigan, School of Information, USA
POOJA UPADHYAY, University of Maryland, College of Information Studies, USA

Visual online communities can present accessibility challenges to older adults or people with vision and motor disabilities. Motivated by this challenge, accessibility and HCI researchers have called for voice-based communities to support aging and disability. This paper extends prior work on voice community design and short-term use by providing empirical data on how people interact with voice communities over time and intentional instances of non-use. We conducted a one-year study with 43 blind and low vision older adults, of whom 21 used a voice-based community. We use vignettes to unpack five different voice community member roles - the obligatory poster, routine poster, cross-platform lurker, busy socialite, and visual expertise seeker - and discuss community interactions over time. Findings show how participation varied based on engagement in other communities and ways that participants sought interaction. We discuss (1) how to design voice communities for member roles and (2) the implications of synchronous and asynchronous voice community interaction in voice-only communities.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**; **Auditory feedback**; *Empirical studies in collaborative and social computing*; **Empirical studies in accessibility**;

Additional Key Words and Phrases: IVR systems, voice community, older adults, aging, blind and low vision, disability

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1 INTRODUCTION

To date, there has been little agreement as to whether online communities are more helpful or harmful. While online communities can help people find shared interests through groups and exchange information or support [35], people can also use them to spread mis/disinformation or amplify societal inequity [17, 51]. Extending this argument, online communities can be beneficial

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Authors' addresses: R. Brewer, S. Ankenbauer, and M. Hashmi, University of Michigan, School of Information, 105 S. State St., Ann Arbor, Michigan, USA, 48105; e-mail: rnbrew@umich.edu; P. Upadhyay, University of Maryland, College of Information Studies, USA.

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for historically marginalized groups. Yet, they can also be inaccessible for older adults and blind and low vision people due to late-life disability impacting assistive technology adoption [37]. Access constraints can also impede online community use as these communities often require access to costly internet connections or devices to engage online[18].

Recently, researchers have argued that voice technologies can provide more accessible ways to engage with information and other people. For example, smart speakers (e.g., Amazon Alexa) can make it easier for people with limited motor ability or visual disabilities to access information than on laptops or portable mobile devices. However, smart speakers can present access constraints for those with limited internet connection. Accessibility and global development scholars have pushed for more work on telephone-based voice communities and **Interactive Voice Response (IVR)** communities where people can interact with information on a landline or non-smart cell phone [10, 12, 36, 42, 54]. Research on phone-based voice communities often describes how people use them from a quantitative log data perspective or presents short studies of voice community use (e.g., [10, 12, 36, 38, 54]). However, fewer studies provide in-depth qualitative narratives of voice community use over time.

In this paper, we build off our prior work piloting xPress, an IVR voice community for blind and low vision older adults, across 10 weeks. Our prior work showed how blind and low vision older adults started to use xPress to discuss disability [12]. Although motivated by online community use and its benefits to social well-being, this study needed a larger sample size to fully investigate well-being effects. In this study, we sought to:

- Investigate how loneliness and social support, two social well-being constructs, are affected by xPress use
- Complement quantitative data with qualitative narratives of voice community use
- Share how blind and low vision older adults used a voice community over time

To do so, we conducted a one-year field experiment with 43 blind and low vision older adults. Some were randomly assigned to the intervention condition where they used xPress. Others were assigned to the control condition and did not use xPress. Although not statistically significant, we found that loneliness decreases were more pronounced in the first six months of the deployment, and social support increases were more pronounced in the last six months for those who used xPress. xPress activity mimicked behavior in other online and offline communities. Namely, more active users either expressed a need for connection with others with shared disability identities or an inherent desire for engagement reciprocity. Less active users often had active offline disability communities of practice or were active online using assistive technologies for visual disabilities. Using these data, we also extend prior work on roles in screen-based online communities [6] to categorize user roles in a voice community. Lastly, we describe how people envisioned future voice communities promoting social support. More broadly, this work contributes to research on designing more accessible online communities and extends work on voice technologies beyond purely informational use to social use. Specifically, we provide three contributions to the HCI community. First, we extend research on the role of less visible online community activities [3, 13] by contributing voice community member vignettes using participant data with visible and less visible engagement patterns. Second, we report voice community use over time, rather than short periods, allowing us to describe patterns of activity and inactivity that mitigate novelty effects. Third, we discuss the nuances of synchronous and asynchronous interactions in voice-only communities, which we argue have different affordances than voice communities with visual features (e.g., Clubhouse, livestreaming).

2 RELATED WORK

2.1 Towards Intersectional Digital Experiences

Much research has explored older age or disability, but outside of dementia research, little work has investigated intersectional experiences of older adults with disabilities. This paper investigates these intersectional experiences because late-life disability is prevalent. According to recent reports, 15% of the world population has at least one disability, while 46% of people over 60 years old have at least one disability [53].

Disability and older age are also critical to understand as they affect how people access and engage with technology. Dobransky and Hargittai show that 80% of non-disabled people use the internet, whereas only 47.8% of disabled people use the internet [18]. With age, 82% of adults 65–69 use the internet, whereas only 44% of adults ages 80+ use the internet [2]. While these reports do not report on the intersection of late-life disability, they suggest that disabled older adults may face additional barriers to engaging in online communities. In the following sections, we present literature on the role of offline and online communities of practice for aging and disability. Next, we highlight access gaps in both that motivate turning attention toward voice-based communities. Lastly, we describe relevant research on voice technologies' role in community engagement within aging and disability communities.

2.2 Communities for Aging and Disability

Narratives of late life and disability highlight how connection and community can benefit older adults and disabled people. Offline, communities of practice align with values of "healthy" or "successful aging" [1] and connect people with shared identity characteristics (e.g., disability) [24]. However, in-person communities are often critiqued as they limit access for disabled people with transportation or mobility challenges or those who live in areas that are less likely to have a critical mass of older adults or disabled people to sustain community activities.

To address these access challenges, researchers have looked towards online communities. Online communities can mitigate disability-related stigma as people can usually choose whether and how to disclose disabilit(ies) or older age [7]. Baker et al., (2013) show how older adults and disabled people use "group" features in communities like Facebook and LinkedIn to network and form community [4]. However, online communities may not be accessible for those without internet access, people with fine motor impairments, or blind and low vision people. While assistive technologies such as screen readers or speech-to-text tools can support disabled people, prior research has shown how late-life disability complicates access. For example, blind and low vision older adults experiencing late life vision loss can feel overwhelmed with learning to use technologies (e.g., computers, smartphones) and their assistive features (e.g., desktop and mobile screen readers) [37]. Researchers have discussed voice communities as an approach to mitigate many of the challenges that in-person and screen-based online communities present for aging and disability [10, 38, 39, 52].

2.3 Understanding Voice Communities

Voice communities can take varying forms, including Interactive Voice Response systems accessible on landline or non-smart cell phones [36, 42, 54], standalone voice-only platforms accessible on smartphones (e.g., Clubhouse), or voice features integrated into existing online communities (e.g., X (formerly known as Twitter) Spaces, Discord, TikTok, voice memos in private messaging applications) [5]. Prior work in these communities often highlights design features that users find meaningful or focuses on users' engagement patterns. For example, Jung et al. (2022) interviewed Clubhouse users finding that voice afforded more intimacy when compared to text conversations,

and users disclosed sensitive information or discussed controversial topics with an unknown audience [23]. Similarly, [15, 41, 56] confirms users perceive voice-based communication to be more intimate and authentic than screen-based communication. Other research shows how people engaged with Interactive Voice Response communities for entertainment to record "cultural content" such as songs, poems, or jokes; how often users created posts, listened to content, or upvoted content [54].

While often combined with visual content, research on livestreaming platforms such as Discord, TikTok, Meerkat, and Periscope describe synchronous and asynchronous interaction benefits, motivations for participation, and how features such as private messaging are useful to community members [29, 50]. Interviews with queer TikTok users show how they use streaming and content creation platforms to connect with people with less visible identities, yet also reinforce harmful stereotypes [48]. Other critiques of voice communities (or online communities with voice features include parasocial relationships) [25], limited audience awareness [34], polarization [15], difficulties discovering new content or quality conversations [41, 50], and limited content moderation [15]. To address these critiques, researchers have focused on improving voice expression and customization to strengthen intimacy [58], and community-based content moderation approaches [54]. In this paper, we complement research on voice community use patterns with a more qualitative understanding of voice community users, focusing on blind and low vision older adults. We contribute vignettes of voice community user roles to unpack more and less visible engagement patterns in voice communities.

2.4 Voice Communities for Aging and Disability

Within aging and disability communities, prior work has emphasized how Interactive Voice Response systems and voice assistants can provide easier access to communities and information for blind and low vison people and older adults. For example, Baang was an Interactive Voice Response community popular with blind and low vision people in India [42]. Rong et al. (2022) found that blind and low vision people found it difficult to create "visually engaging content", understand visual content (e.g., real-time comments), and engage with sighted users on livestreaming platforms [44]. They encouraged researchers to develop better approaches to provide image and video descriptions for improved content creation. Brewer and Piper (2017) designed and evaluated an Interactive Voice Response community with blind and low vision older adults, finding that IVR communities can provide outlets for sharing information about disability and connecting with people with similar identity characteristics [12], similar to group features on Facebook [4]. However, participants wanted more engagement opportunities and better ways to understand less direct forms of participation, similar to older adults' preferences on visual communities like Facebook [13].

Voice assistants can also provide a more accessible alternative to visual online communities. Pradhan et al. (2018) find that disabled people use voice assistants to complete tasks more quickly and independently [39]. Other research describes how older adults increasingly use (or wanted to use) voice assistants for general and health information seeking [11, 31, 38]. Research has recently shown how older adults desire to use voice assistants for more social purposes [38, 46]. Yet, there are concerns about doing so in varying residential environments. Concerns include information credibility, refusal/non-use, usability, and usefulness [11, 38, 52]. This paper explores how voice technologies can support social interactions among blind and low vision older adults.

3 XPRESS

This paper investigates how blind and low vision older adults use the xPress voice community. xPress is an Interactive Voice Response community where community members/users interact

through keypad input to create blog posts by voice. Its design was motivated by formative research with sighted and blind and low vision older adults [10]. We designed xPress as a voice community for blind and low vision older adults based on our preliminary work showing immense value from being able to connect with others with late-life disabilities [12]. Our findings from this work show how important it is to have communities that prioritize less visible identity categories and counter mainstream spaces for younger people or people without disabilities.

People engage with xPress by dialing a toll-free number and selecting a number to engage in one of three key system activities. Users can either listen to someone else's posts, listen to their own posts, or create a new post. While listening to posts, they can leave voice comments or skip to the next post. Similar to drafting and publishing features on blogging communities, after recording a post, xPress users can either re-record the post or publish it for other xPress members to hear.

Based on the initial xPress deployment [12], in the updated version of xPress, we made two key changes; we (1) provided an audience awareness feature and (2) removed Tumblr integration. As participants in the initial deployment sought better ways to learn about people who were listening but not commenting on posts, the updated xPress community notifies users of how many people have commented on *and* listened to their posts when users dial in. We also play how many people have listened to and commented on individual posts as users browse through posts. As such, the current version of xPress promotes better social awareness [27]. In addition, xPress users in the pilot deployment did not share their Tumblr blogs with family members and friends because they enjoyed having a safe space to learn about late-life disability. We removed the Tumblr component and focused on xPress-only user interactions to preserve this safe space.

We share more details about xPress's design in [12]. The current paper focuses on how xPress was used over time with a larger sample size. We did not recruit participants from the previous study to participate in this study.

4 METHODS

We conducted a one-year field study with an experimental design with blind and low vision older adults to understand xPress use over time.

4.1 Procedure and Participants

The study design consisted of four phases: (1) recruitment and screening, (2) a pre-interview and survey, (3) phone check-ins, and (4) a post-interview and survey (Figure 1).

Recruitment and Screening: We recruited participants through email and listservs after IRB approval. We recruited by sending emails to n = 1,254 eligible patients in the University of Michigan DataDirect database, which includes all patients in the university's medical system. We also received approval to recruit through the National Federation of Blind and sent an email announcement to their senior division to reach people in our target age group (exact list-serv numbers not publicly available). People were eligible to participate if they were over age 65 and identified as blind or low vision. We used a screening survey to further determine eligibility because some people may identify as having low vision, but have corrective vision loss vision that can be corrected with surgery, glasses, or contact lenses, which would make them ineligible for the study.

We asked everyone who responded to our recruitment campaigns to complete a verbal screening survey with a researcher by phone to confirm eligibility for the study. In this screening survey, we asked specific questions to determine whether participants had non-corrective vision loss as our prior work shows how those with corrective vision loss preferred to use screen-based rather than audio technologies [10]. We operationalize non-corrective vision loss as visual acuity of <= 20/200 in someone's better-seeing eye. The screening survey included demographic questions and questions from the **Impact of Vision Impairment (IVI)** scale, a validated and robust scale

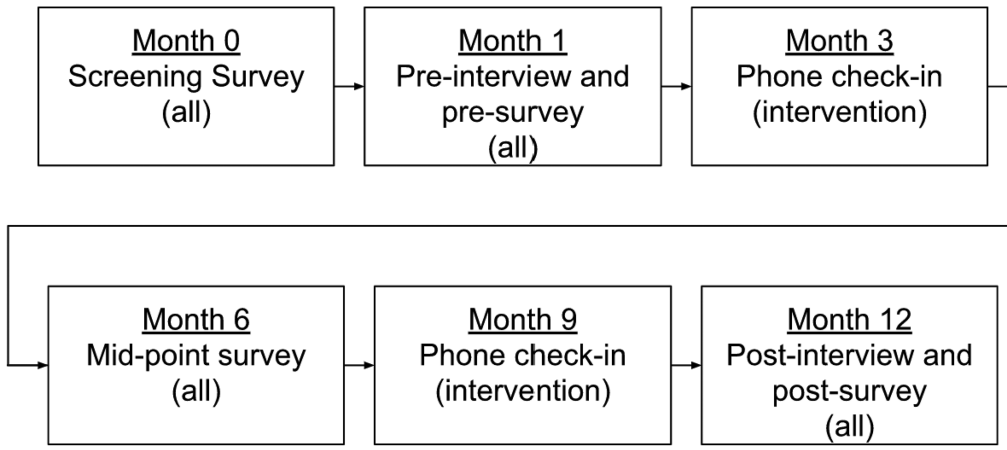

Fig. 1. Procedure flow for intervention and control condition participants in the research study.

to measure functional vision impairment [26]. Scores on the IVI scale can range from 0–78. Those who report often have difficulty accomplishing activities listed in the IVI 'a fair amount of the time' are those who are likely to have a non-corrective vision impairment. Therefore, we identified people as eligible for the study if they had an IVI score < 40. Between May 2020 and October 2020, we screened 122 potential participants and recruited 43 eligible participants on a rolling basis (ages 65–89, average age = 72, 27 female, 16 male, 16 blind, 25 low vision). We randomly assigned 21 participants to the intervention condition (ages 65–84, average age = 73, 13 low vision, 8 blind, 11 female, 10 male) and 22 participants to the control condition (ages 65–89, average age = 70, 16 female, 6 male, 14 low vision, 8 blind). Of these, six participants in the intervention condition withdrew from the study during the one-year period due to low use or utility.

Pre-interview and Survey: We onboarded participants throughout the recruitment process (May - October 2020). Onboarding consisted of receiving consent, conducting pre-interviews, providing instructions about xPress (for the intervention participants), and conducting an oral pre-survey. After determining eligibility and receiving consent from participants, we conducted pre-interviews by phone. In the pre-interviews, we asked about general community patterns and technology use. We randomly assigned all eligible participants to the control or intervention condition. For those in the intervention condition, we also asked about their familiarity with blogging and provided instructions for accessing xPress. These instructions included the toll-free phone number to dial into xPress and an overview of phone tree-like structure. The interviewer encouraged all participants to dial in, listen to a post, and comment on a post within a week of their pre-interview to answer any questions about system design/use. Those assigned to the control condition did not receive questions about prior experience with blogging or a tutorial and did not receive access to the xPress system.

During the pre-interview, we also administered a verbal pre-survey with all participants. This survey consisted of questions to understand two components of social well-being - loneliness and perceived social support [14, 28]. We measured loneliness with the validated UCLA three-item scale [21], a widely used scale used for phone surveys and with older adults and the appraisal and belonging subscales from Cohen's validated 20-item ISEL measure of social support [16]. The appraisal subscale includes 10 questions and measures the "perceived availability of others to talk to". The belonging subscale includes 10 questions and measures the "perceived availability of others to do things with". Respondents rate each item on a four-point scale of definitely false (0) to definitely true (3). Each of these scales are shorter than their original (UCLA loneliness) or full (ISEL) scale to

minimize cognitive burden on participants when completing verbal surveys. Further, we note that we use the UCLA three-item loneliness scale to assess loneliness and do not explicitly ask participants to describe loneliness in interviews. Similar to the rationale for why the 3-item, revised, and original UCLA loneliness scales do not explicitly ask about loneliness, we similarly chose to use indirect measures because of potential social desirability bias and a 'loneliness paradox' in which we did not want to prime participants to hyperfocus on loneliness throughout the study [21, 33, 45].

Phone Check-Ins and Mid-Survey: There were periodic phone check-ins with all participants throughout the study. For those in the intervention condition, check-ins occurred every three months. For those in the control condition, check-ins occurred every six months. During each check-in, the researcher asked questions to understand any changes in communication patterns (all) and xPress use (intervention). At the six-month check-in, the researcher verbally re-administered the loneliness and social support survey from the pre-interviews.

Post-Interview and Survey: After one year, a researcher conducted post-interviews with each participant. This post-interview included questions to understand whether and how communication and social behaviors changed within the last year. The researcher asked participants in the intervention condition about xPress usability, usefulness, and ease of use. The researcher re-administered the loneliness and social support survey from the pre-interviews in month one and mid-point phone check-ins in month six.

4.2 Analysis

This study resulted in several forms of data output, including interview and phone check-in recordings, survey data, log data, and system content.

Interview Data and Phone Check-in Recordings: We recorded and transcribed all interviews. We qualitatively coded pre- and post-interview data using a reflexive thematic analysis approach. In its original conceptualization, reflexive thematic analysis involved a six-step process including familiarization, coding, generating themes, reviewing themes, refining themes, and communicating a narrative [8]. In an updated reflection, Braun and Clarke describe how reflexive thematic analysis should not emphasize "following procedures correctly" [9], rather the goal is for the researcher to thoughtfully and iteratively engage with the data. As such, we loosely align with stages of reflexive thematic analysis. Two research team members read each transcript (familiarization), highlighting patterns related to the study objective (coding). Following an inductive approach, we used these patterns to generate key themes related to communities, social well-being, disability, aging, and xPress use (generating themes). Through constant discussion with the research team (generating, reviewing, and refining themes), one researcher iteratively coded the transcripts according to these themes (iterative coding). We did not rigorously code phone check-ins but read through the transcript of each check-in, memoing and noting any patterns related to current or desired xPress use.

Log Data: Log data included the participant's key interactions relating to two primary roles, being a (1) listener and (2) contributor. xPress logged each time a participant: dialed in, listened to a post, listened to a comment, created a post, and created a comment. Prior work describes listening as an active form of participation amongst older adults in online communities [13]. Therefore, we descriptively analyzed raw counts for each of these metrics and categorized participants into "active listener" and "active contributor" roles. We categorized those who were in the top quartile of listening to others' posts and comments as an "active listener" and those in the top quartile of creating posts and comments as an "active contributor."

Survey Data: We collected pre-, mid-, and post-survey data for each participant. We computed the average loneliness and social support scores according to scale instructions. We descriptively analyzed and plotted the mean loneliness and social support scores by condition and by participant.

Next, we used a linear mixed model approach to understand how using xPress affected social support or loneliness. We initially had four hypotheses to predict (1) the direction of social support [H1] and loneliness [H2] for those in the intervention and control groups and (2) how activity as a listener affected loneliness [H3] and a contributor affected social support [H4]. During the first survey analysis phase, we used a binary indicator of activity (yes/no) as the independent variables, baseline scores (loneliness, social support) as covariates, and some demographic variables as sociodemographic confounders. We also include a random intercept in each model to allow models' intercepts to vary among individuals. However, we did not find a significant association between participation and social well-being factors. During the second survey analysis phase, we measured participation as a continuous variable. We did not adjust for sociodemographic confounders with such a small sample size. In the third survey analysis phase, we used ANCOVA to measure pre/post measurements rather than directly modeling score changes [55]. However, none of these models produced statistically significant results. Therefore, we primarily focus our findings on qualitative data and trends in quantitative data. One benefit of the study is that it supported blind and low vision older adults during the early and middle stages of the COVID-19 pandemic. Yet, we hypothesize that we did not observe statistically significant results because participants engaged in varying distancing and isolation behaviors throughout the study that affected social support and loneliness.

System Content: Lastly, we transcribed all posts and comments that participants created while using xPress. Similar to interview transcript analysis, we read through all posts and comments. Next, one research team member developed a codebook based on patterns related to topics that participants discussed and coded each transcript according to this codebook. Example codes include seeking advice, blindness, older age, celebrations, COVID, and family. In the findings, we used the system content to contextualize interview responses and system behaviors.

4.3 Reflection and Limitations

We made certain methodology compromises to conduct this study during the COVID-19 pandemic. First, we intended to recruit a larger sample size to quantitatively investigate how xPress uses impacts measures of social well-being. We contacted more than 1,000 potential participants in five months and screened 122 potential participants, yet only 43 were eligible and interested in participating. We suspect this is because the phrase "low vision" can be used to identify people with corrective and non-corrective vision loss, yet many of the people we contacted had corrective vision loss, making them ineligible for the study. Therefore, our quantitative data is purely descriptive and does not imply statistical significance.

Further, we suspect that varying COVID-19 social distancing guidelines may have been a confounding variable affecting loneliness and social support. Besides conducting this work outside of a global pandemic, we could have been more selective during the recruitment process, only recruiting those with specific loneliness or social support scores. Those with more social support, reduced loneliness, or who are already involved in existing communities may find xPress less useful and may use it less than other participants. However, we would have recruited an even smaller sample size. Additionally, we used loneliness (three questions) and social support scales (20 questions) that differed in size, meaning we were limited in observing high variance in the loneliness metric. However, we did so to mitigate cognitive demand in oral surveys and because research has found the three-item scale to work well with older adults [21].

Next, we used a rolling enrollment approach to register participants for the study. We noticed that participants who enrolled later were more frequent xPress users, likely due to experiencing more content within the system at the enrollment time. One option could have been to bootstrap or pre-populate content so that those who enrolled earlier would have heard the same amount of

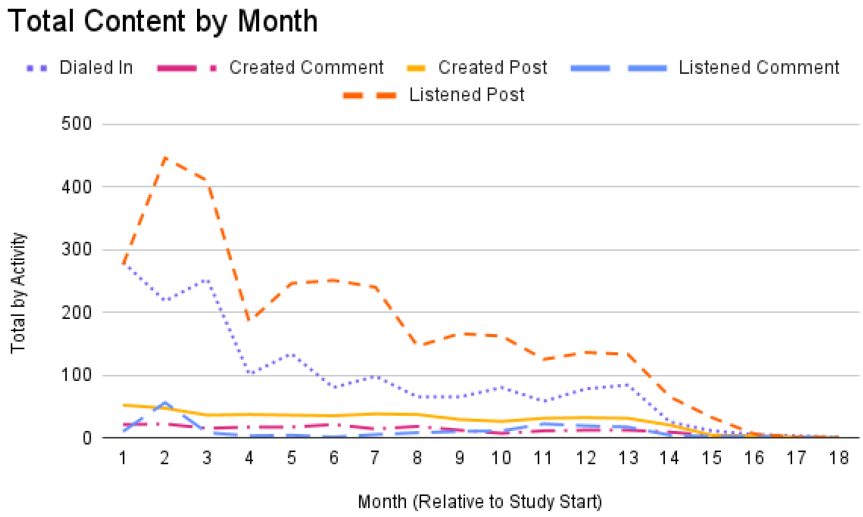

Fig. 2. Content totals over time, relative to study start month.

content as others. However, we had concerns about how to do this authentically as participants who engaged in bootstrapped content in our prior work did not enjoy these interactions [12]. Future work may explore recruiting a larger sample size and enrolling participants at the same time. We could also mimic bootstrapped content with a single start date by creating a "pilot" or "trial" period where the expectation is to create content (e.g., for two weeks) without the option for comments until a specific date.

Lastly, we were unable to contact all participants for post-interviews. For consistency, the findings only include data from participants who completed the loneliness and social support questions at each data collection point. Although there were several participants in the intervention condition who did not engage with xPress much, we find it valuable to describe and show instances of use and non-use.

5 FINDINGS

First, we summarize xPress use, including trends from loneliness and social support survey data and how participants envisioned future voice communities. Although not statistically significant, we find that xPress use had the most impact on loneliness within the first six months and on social support within the last six months. As prior work focuses on summarizing voice community log data, we also present qualitative data contextualizing system use. We include vignettes of participant roles based on frequent and infrequent xPress posters and listeners. Their xPress use reflects participation on other platforms and the interaction they expected in the community.

5.1 xPress Participation

First, we present an overview of the log data to show how participants in the intervention condition used xPress throughout the study. Data logs show how participants engaged in 6,193 unique interactions with xPress. Of these, participants dialing in 1,717 times, listened to 3,575 posts, listened to 192 comments, created 495 posts, and created 214 comments (Table 1). The mean post duration was 96.58 seconds and mean comment duration was 43.24 seconds. Figure 2 shows how participants engaged with xPress over time. The study took place between months 1 and 13, yet several participants (P5, P9, P11, P17, P20, P29, P37) used xPress after the one-year study period.

Table 1. Overall xPress use by Intervention Participants in the Log Data (which May Include Some use after the 12-month Study Period)

PID	Dialed In	Listened to Posts	Listened to Comments	Created Post	Created Comment	Overall
1	3	5	0	0	0	8
3	10	16	0	1	0	27
5	18	52	2	10	5	87
7	119	126	21	30	17	313
9	91	153	12	13	6	275
11	59	78	20	34	26	217
13	2	11	0	0	0	13
15	3	5	0	1	1	10
17	91	278	0	1	0	370
20	256	334	23	184	106	903
21	0	0	0	0	0	0
23	74	333	2	5	4	418
25	318	662	78	22	12	1,092
27	1	6	0	0	0	7
29	216	206	11	185	31	649
31	278	769	17	2	2	1,068
33	0	0	0	0	0	0
35	1	2	0	0	0	3
37	39	144	0	3	3	189
41	116	345	5	2	1	469
43	22	50	1	2	0	75

This figure shows how there were peaks in dialing into xPress in months 1, 3, and 5. We observe similar patterns for listening to posts, with participants listening to posts most often in months 1–3 and 5–7. Creating posts and comments remained fairly constant. Listening to comments did not happen frequently and mostly occurred in month 2 and after month 10. Figure 3 shows all participants who used xPress during the study.

5.1.1 "Active" Varies by Role. We noticed variations in "active" roles when we examined individual participant use. As prior work has critiqued studying "active" online community use only focusing on people who create content [3, 13, 19, 20], we discuss activity based on content listeners and contributors. For example, $P17_{i\text{-}post}$[1] said, "*sometimes I like just listening to what other people have to say.*" Similarly, $P23_{i\text{-}post}$ discussed the potential for others to listen, saying, "*a lot of people could have been like me, where they listened, they absorbed, they maybe learned something.*" We found that some participants were highly active listeners, intentionally listening to others' posts and comments. The most active listeners were P41 (listened to 350 posts and comments) and P25 (listened to 740 posts and comments).

Others were active contributors, creating posts and comments. For example, $P5_{i\text{-}post}$ said, "*every once in a while, you'd find somebody spirited. And that's what struck my fancy. So I would go to their post and then post something for them. And I thought that was pretty good.*" This quote describes how P5 was intentional about which posts she commented on. In contrast, $P20_{i\text{-}post}$ "*would say*

[1]We use a subscript notation throughout the findings section where "i" indicates a statement by an intervention condition participant, "c" for a control condition participant", "pre" for a pre-interview quote, and "post" for a post-interview quote.

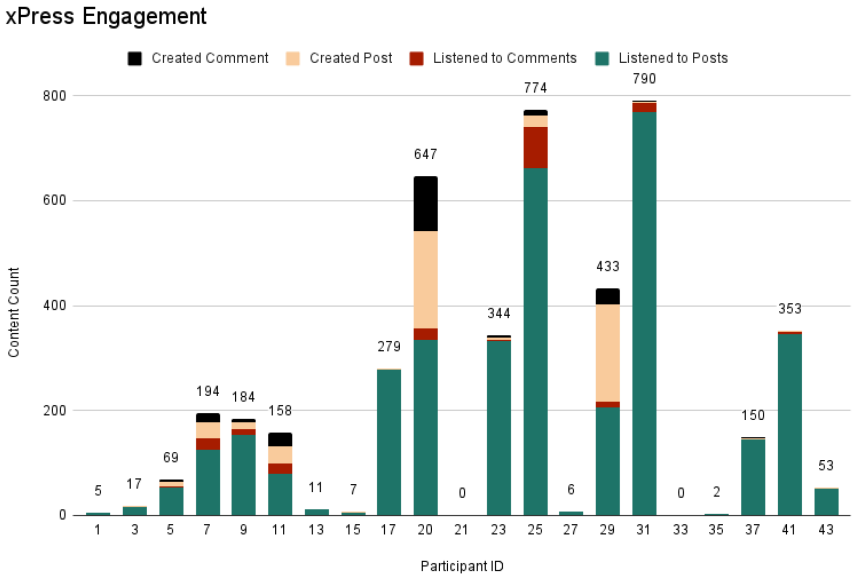

Fig. 3. How intervention participants engaged with xPress during the study including creating comments and posts and listening to comments and posts.

95% of the time when I listen to someone, I respond. [...] If someone takes the time to post, it should be noted that somebody's listening. So I don't judge what I'm listening to. I respond to it regardless." P20's contribution behaviors were also intentional, but in a way that complemented her listening behaviors and made the audience more visible. P20 was the only person to describe an obligation to comment, which played a part in her log data patterns. The most active contributors were P20 (created 290 posts and comments) and P29 (created 216 posts and comments). The least active xPress users (who did not withdraw from the study) were P3, P11, and P33. We unpack xPress use from the most and least active participants in Section 5.4.

5.1.2 Disability and Profiles in Posted Content. Lastly, we provide an overview of the post and comment content. The most discussed topics related to family (143 posts and comments), weather (89 posts and comments), xPress design (71 posts and comments), and COVID-19 (58 posts and comments). We discuss these topics throughout the findings, yet also wanted to highlight *how* participants used their posts. Similar to prior work about small online communities [22], most participants discussed disability-related information in posts or comments. Some directly sought advice and opinions from others. For example, $P25_{i\text{-}post}$ said, "*It's very satisfying to be able to hear other people who have the same vision problems that I have to hear what they have to say, how they're coping.*" Asking for disability-related advice was a common post topic from the pilot xPress deployment [12].

Participants also posted introductions, similar to profiles or bios on social media sites. For example, P43 introduced himself by saying, "[...]*If anybody likes professional wrestling, you can check it out, it's on. You can look up [wrestler name]. You can Google me. You can read my story* [...]." In this post, P43 briefly describes his unique profession, a wrestler, and points listeners to where listeners could find out more information about him.

Others used posts and comments to detail unique events in their lives. For example, P7 posted:

Table 2. Raw Loneliness Scores over Study Duration for Intervention (xPress) and Control (no xPress) Participants

	month 1	month 6	month 12	month 1–6 change	month 6–12 change	month 1–12 change
intervention	5.727	5.364	5.273	−.363	−.091	−.454
control	5.12	5	4.75	−.12	−.25	−.37

A lower score denotes a lower level of loneliness.

> "When I was about seven years old, I would watch cartoons on TV. And sometimes I would see a character jump off of a cliff or a building, and he would hold an umbrella, an opened umbrella, and float gently to the ground. One day I was playing in my parents' bedroom and I found an umbrella. I went out back to a garage that's not attached to our house. At the back of the garage, there's a large tree growing with one limb close enough to the ground that I could grab it and pull myself up into the tree. Then I would move up the branches until I was on one branch where I could step over onto the roof of the garage. And then I walked on the roof up to the highest point of the garage. And then I opened the umbrella and I jumped, expecting to float gently to the ground, but I hit the ground with a smack that jarred my teeth. So I learned that things don't work on TV as they do in real life. This is [P7] in [state]. Goodbye."

This post garnered attention on the system, receiving two comments from participants, but also was discussed often with researchers during in phone check-ins with intervention condition participants.

Lastly, we note our intentional decision to qualitatively discuss posts and comments together as participants often used posts to respond to others' posts.[2] For example, P27 said, "[...]*I wanted to thank [P5] for the very useful information she put up about the NFB. And I followed up on the links that she mentioned and found it to be a gold mine of potential information. So thank you [P5] for the very useful post* [...]." During phone check-ins, participants described being unsure how to leave a comment, likely contributing to the trend of posts being used as comments.

These findings show how participants used the xPress voice community to engage with content by posting and listening, share their experiences with disability, and receive disability-related support. Next, we use survey data to share (1) how isolation contributed to xPress (non)use and (2) the role of voice for providing social support.

5.2 The Role of Loneliness and Isolation

5.2.1 Decreased Loneliness for xPress Users. Because loneliness is increasingly prevalent amongst older adults [32, 57], we sought to understand how loneliness changed over time for participants in the intervention and control conditions. We measured loneliness at three periods - pre-interviews (month 1), mid-point interviews (month 6), and post-interviews (month 12).[3] There were no statistically significant differences over time between intervention and control participants.

Loneliness decreased for all participants (Table 2, Figure 4). However, we observed a larger difference in loneliness scores for participants in the intervention condition than in the control

[2]Note: All log data presented in charts and tables separates posts and comments. They are not counted twice when presenting data quantitatively.

[3]In the remainder of the paper, we report on loneliness and social support only from participants who completed each survey (pre-, mid-, and post-interviews).

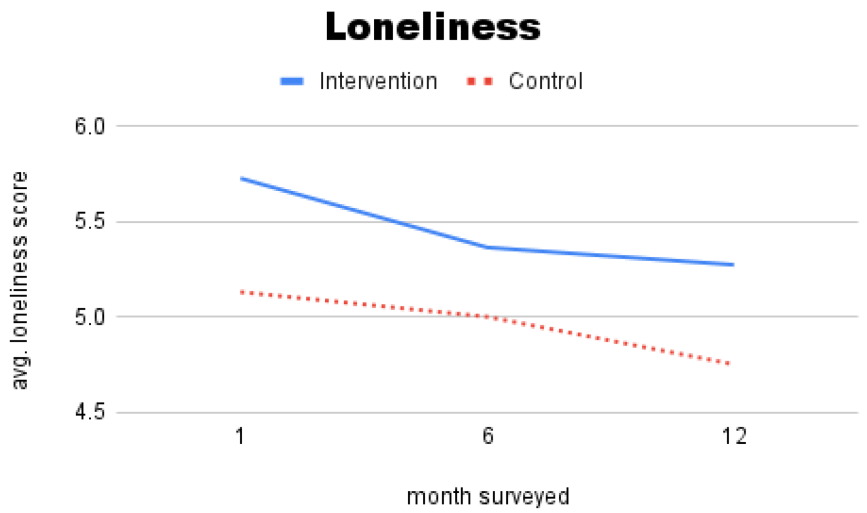

Fig. 4. Loneliness over time where a lower score means less loneliness.

condition overall, specifically during the first six months of the study. In other words, there was a larger decrease in loneliness for those who used xPress in the first six months compared to those who did not. This time period coincided with the harshest social distancing and isolation measures due to the COVID-19 pandemic. We speculate that there was not a significant change in loneliness scores for those in the intervention condition during the last six months because participants were increasingly exposed to family members and friends due to looser COVID-19 restrictions. Therefore, we posit that a voice-based online community like xPress could be more useful for those who are more socially isolated. While we speculate varying COVID-related isolation regulations and behaviors was a confounding variable affecting loneliness, our sample size was not large enough to measure this effect. Therefore, the remainder of this section focuses on qualitative interview data to contextualize intervention and control participants' desire for community throughout the study.

5.2.2 Desire for Community. All participants discussed the need for community during their pre- and post-interviews. For example, "*right now I'm looking for a friend, I'm looking for a voice chat, you know, a friend, something like that*" (P33) or "*COVID isolated us from other people, and it's still going on*" ($P41_{i\text{-}post}$). We enrolled participants between May and October 2020 when social distancing requirements were strict, which may have affected their desire for community. However, many participants noted that their age or vision disability contributed most to their loneliness and isolation. Participants described how "*once I became legally blind, some people faded out of the picture*" ($P44_{c\text{-}post}$), "*being unable to see is isolating*" ($P25_{i\text{-}post}$), or "*being blind kind of get[s] isolated because nobody knows what to do around you* [...] *you really have to be an outgoing person in order to be seen*" ($P43_{i\text{-}post}$). In each of these examples, participants described how sighted people isolated them after their blindness.

Others described their experiences with aging. For $P20_{i\text{-}post}$, their "*friends are few though. That's the situation at this stage of the game. I need a great séance mediator in order to contact my friends. Friends from past lives.*" P20 continues by describing how many of her friends had passed away and forming new relationships was difficult. Similarly, participants described how engaging in person had become difficult or stopped altogether. Aligning with prior work on long-term care communities and loneliness [40], $P23_{i\text{-}post}$ said, "*I just feel very isolated, even though I'm in this complex.*" $P29_{i\text{-}post}$ lived in a senior residential community which "*used to have birthday parties,*

Table 3. Social Support Scores over Study Duration for Intervention (xPress) and Control (no xPress) Participants

	month 1	month 6	month 12	month 1–6 change	month 6–12 change	month 1–12 change
intervention	31	34.364	28.455	+3.364	−5.909	−2.545
control	32.81	34	31	+1.19	−3	−1.81

Lower scores mean higher perceived social support.

bingo, all kinds of stuff in the community room, exercise and stuff like that. That has stopped since the pandemic [...] I haven't really tried very hard [to make new friends]. Because again, there's just no way." Before the pandemic, P29 also belonged to a support group for people with low vision.

Since developing in-person relationships was challenging, participants described attempts to strengthen their digital skills to form relationships online. However, learning to use assistive technologies with smartphones and computers was challenging. $P4_{c\text{-}post}$ said, "*The blind people I know who really are good with the iPhone, they seem to use the iPhone for almost everything. But I'm not that tech-savvy.*" $P8_{c\text{-}post}$ also shared how disability and age affected computer use saying, "*At my age, I can't see that happening anymore.*" Similar to prior work showing technology non-use due to age and disability [37], P32 said:

> "I figured out that it was a waste of my time to spend a couple hours a week with an instructor virtually, trying to learn how to do everything over a virtual connection on technology with the computer. And I finally just said, it's super frustrating, because there was so much troubleshooting going on with things not working properly with the software and everything. And I finally just said, this is too stressful trying to do this virtually."

Like other participants, P32 describes how learning to use a screenreader to access online communities was burdensome. Yet, without assistive technologies, social media remained inaccessible or unusable. For $P19_{c\text{-}post}$, Facebook's "*regular display that sighted people use is just too busy, there's too much going on, and I find it really, really difficult to use*" and $P34_{c\text{-}post}$ "*would like Pinterest, but the pictures are very difficult for me to see. It's kind of too convoluted for me.*"

These quotes show how participants had a strong desire for community and developing new relationships before the COVID-19 pandemic. This desire increased due to a lack of in-person events at senior centers or vision-related support groups. They tried developing community online through existing platforms, but these were inaccessible without assistive technologies. Moreover, learning to use assistive technologies was a cognitively demanding and inaccessible process. Thus, an alternative community like xPress had the potential to reduce loneliness. While confounding COVID-related variables likely affected observing statistical differences in loneliness between those in the intervention and control conditions, we see more stark decreases in loneliness during the first six months of the study, suggesting voice-based online communities may have larger effects on loneliness when people are extremely isolated.

5.3 Voice, Communities, and Support

5.3.1 Higher Social Support for xPress Users. Social support is one factor that mediates loneliness and its health-related effects (e.g., depression) for older adults [47]. Therefore, we also measured perceived social support over time for participants in the intervention and control conditions. Similar to measuring loneliness, we verbally surveyed participants during months 1, 6, and 12 of the study (Table 3).

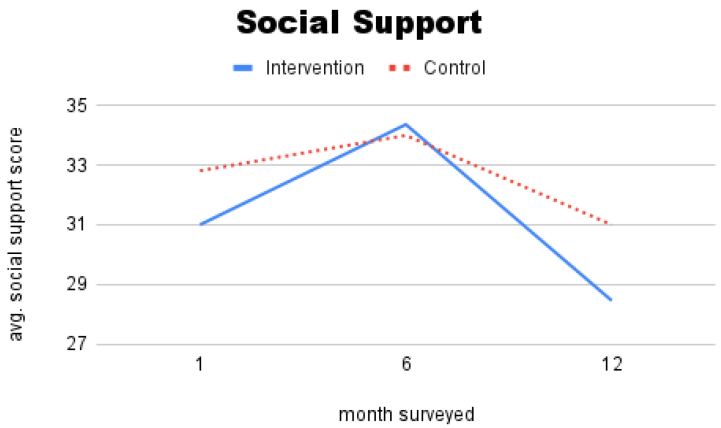

Fig. 5. Social support over time where lower scores mean more perceived social support.

We did not observe statistically significant differences between participants in the intervention and control conditions. Similar to the loneliness findings, trends show that social support scores decreased for participants in both conditions during the study, meaning perceived social support increased (Table 3). Unlike the consistent decrease we observed in loneliness scores, social support trends changed somewhat unexpectedly. We anticipated that social support would increase over time for participants in the intervention condition (meaning social support scores with the ISEL scale would decrease). While we observed this overall change between months 1 and 12, participants experienced an increase in social support scores (lower perceived social support) between months 1 and 6 (Figure 5). Further, this increase was slightly higher for participants in the intervention condition than in the control condition. This change was unexpected because loneliness scores decreased the most in the first six months for all participants. However, we also observed a more drastic decrease in social support scores (higher perceived social support) between months 6 and 12 for participants in the intervention condition than in the control condition. While previous work suggests a relationship between social support and loneliness, our findings suggest there may be temporal effects between the two measures where decreased loneliness may precede increased social support. However, we would need more data to confirm this hypothesis. In the remainder of this section, we provide contextual data as to how people in the intervention engaged in social support behaviors with xPress.

5.3.2 Conversations Through Comments. As in our pilot deployment [12], participants used commenting to engage in asynchronous conversations with others. For example, $P11_{\text{i-post}}$ said "*This one lady, I can't wait for her to come back from Alaska, she said she's going to tell me about her trip.*" Another participant described comments as a way to "*make a friend without seeing... An anonymous friend*" ($P20_{\text{i-post}}$). Describing the non-visual aspects of the system was important to participants and they connected this affordance to their own vision loss, saying "*You're not as visible to other people. And so it's a good way to stay in touch with other people in the low vision community and just to develop maybe like a long distance friendship or something*" ($P29_{\text{i-post}}$).

Participants provided verbal support to others in their comments. For example, P11 expressed support for P7's computer expertise, responding in comments "*Hey, [P7], I'm proud of you. This is [P11].* [...]" or "*Hi, [P7], it's [P11]. I love hearing about all the things you can do. I'm not that good on my computer, but I hope to be working on it, and getting better at it. So you sound like you really know what you're doing, so keep it up. Have a great day.*" Others provided support on major life events

such as birthdays, wedding anniversaries, or deaths. For example: "*[P20]. This is [P23]. My deepest sympathy to you on the death of your dear friend. I truly understand. I had two very, very, very dear friends who died within four months of each other a few years ago, and to this day, I still miss them terribly. Take care.*"

Participants also used comments to give advice. P7 thanked P29 for a book suggestion, saying, "[...]*I listen to a lot of books too, and I like westerns. So I'm going to look for Guthrie, A.B. Guthrie in the Tennessee Library for the Blind and see what all's available. Thanks for the name and suggestion* [...]." Others provided disability-related advice. For example:

> "Hi, [P9], this is [P29]. And I just listened to this post about you worried about getting lost. It is a concern when you can't see where you're going, that's for sure. I had some mobility training, which tells me some, I know where I am around my building, where there's some nice sidewalks where I can go for a walk by myself. I do always take a cell phone with me no matter where I go. Even within my building, in case I have a problem such as getting lost, falling or anything like that. And my cell phone has numbers on it. For example, my kids. But my son, my closest child is 30 miles from me, but in my building, there's nice manager and maintenance people. And I have their numbers on my cell phone because they would be the first ones to help me. And of course, there's always 911. And we have a bus service here, which is door to door for the handicapped and blind, which will take me wherever I want to go and come back and pick me up whenever I tell them to. And they will walk me to the door. That helps too. I don't know if you have anything like that down in Georgia. And I do understand when you say you were nervous. I use a cane. I don't have a guide dog. I use a cane, that gives me a lot of assurance about where I am and where steps and stuff like that are. [...]."

In this comment, P29 provides suggestions for several mobility and safety strategies, including carrying a cell phone, keeping a list of important phone numbers, disability transportation, and a mobility aid. Other comments showed how participants used xPress for casual and critical conversations.

5.3.3 Envisioning Future Voice Communities. Lastly, we explore how participants described the current version of xPress and what they envisioned in future voice communities. Participants' descriptions included "*party line*", "*pen pal but verbal*", "*Facebook without the face*", "*a diary*", and "*conference call.*" These descriptions compare xPress to other asynchronous forms of communication (Pen Pal, Facebook), private communication (diary, pen pal, Facebook), and synchronous communication (party line, Facebook, conference call). Although xPress did not have private messaging capabilities, these descriptions show how participants perceived xPress as a channel for group and private communication.

While xPress was an asynchronous tele-community where posts and comments were audible to all users, participants described how they wanted more synchronous and private communication features during post-interviews and phone check-ins. $P11_{i\text{-}post}$ wanted to "*talk to these people more [...] I'd like more of a give and take ... I almost wish there was a way to get in touch with them one on one.*" Similarly, $P3_{i\text{-}post}$ preferred "*to have a public forum section and then a personal one so that if you wanted to get in touch with someone directly there would be a way to go to their box or something.*" Both participants wanted private communication options, whether synchronous or asynchronous. We designed xPress to be asynchronous to accommodate people with varying schedules and preferences for slower communication and did not observe this desire for synchronous communication in our initial xPress deployment [12]. However, these synchronous preferences align

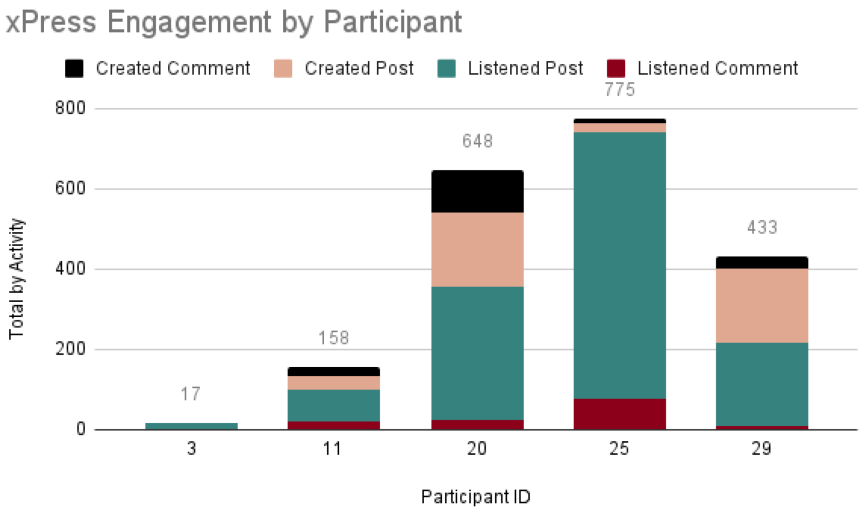

Fig. 6. How the most frequent and infrequent participants used xPress where P3 and P11 engaged with xPress the least, P20 and P29 created the most posts and comments, and P25 listened to the most posts.

with increased streaming or "live" features on social media platforms where people seek quicker communication options to engage in conversation and develop relationships. In the discussion, we return to mixed-synchronicity voice community design.

5.4 Vignettes by Participant Role

This section provides a narrative of frequent and infrequent xPress users. The first three vignettes are based on top posters and listeners (Figure 6). The last two vignettes are based on patterns from three participants who used xPress infrequently or not at all. There were other participants who used xPress less than these three participants, however, those participants chose to withdraw from the study. As such, these three participants represent the least frequent xPress users of those who did not withdraw. Additionally, we combine two infrequent xPress users in one vignette as their experiences were similar. In these vignettes, we describe what motivated participants' system behavior (or lack thereof) based on interview data collected regularly (every 3–6 months) throughout the one-year deployment. We use post content, where relevant, to supplement the interview data. Overall, we find that roles varied based on participants' interactions on other online platforms, schedules based on interest group membership, and visual acuity. Also, posting and listening behavior reflected the type and frequency of interaction they expected in the community.

5.4.1 The Obligatory Poster. P20 posted in the xPress community more than any other participant in the study (185 posts and 106 comments, Figure 7). This level of interaction mimicked her behavior in other online and offline communities. Online, she regularly sent text messages, made phone calls, and interacted on Facebook. $P20_{i\text{-}pre}$ is also very active in the Blind community, describing how "*I'm in a mentor program as a transitional program [for] blind and visually impaired high school kids.*" Although she lives in a senior community for people over the age of 55, she is the only blind person in the community and described being somewhat isolated, saying, "*Some people have other health conditions that would preclude us mingling very much...I have neighbors, but I wouldn't say we're friends. We're neighbors.*" Therefore, $P20_{i\text{-}pre}$ mostly interacted socially by volunteering for a national advocacy group for Blind people across several roles, saying, "*I run an adjustment division loss program...I hold a bunch of offices...Treasurer of one group and vice president*

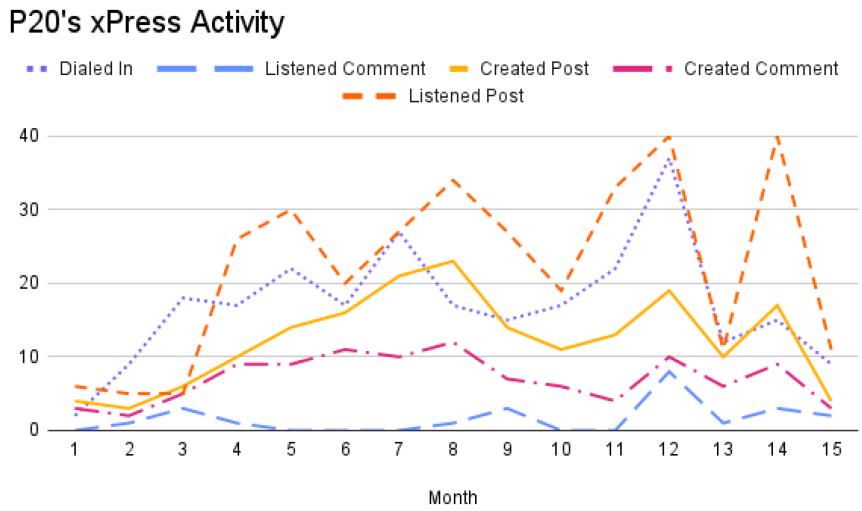

Fig. 7. P20's xPress behaviors over time - primarily posting (posts and comments), little listening.

of another group and communications chair for another. I've got plenty of things waiting, projects and stuff."

P20 was one of the participants who sought conversation and interaction in her posts. For example:

> "I feel very blessed by all of the good things that have happened in my life. The challenges of not seeing were evident all through the day, but somehow rather didn't get in the way of that day, which was pretty nearly perfect. And I'm happy to be able to share my thoughts with everyone. I'm interested in hearing if there are any new things out there that help with the vision. And basically, I really want to hear about other people's stories and their experiences."

While many of her posts described interactions with family (38 posts), the weather (23 posts), routine activities such as cooking (13 posts) or doing chores (10 posts), she also shared intimate topics with the xPress community. For example, she reflected on loved ones who had passed away and family turmoil:

> "It is the longest day of the year. It is also the anniversary of two of my daughters who were both married on this day. I'm happy for them. One marriage is a second marriage, and they are the honeymooners. The other is a long marriage, and at the moment they're not getting along too well, they posted. You're the only ones I've shared this with. Take care everyone. It's going to be a long day."

Reflecting on her xPress use, $P20_{i\text{-}post}$ described an obligation to post and comment, saying, "*It should be noted that somebody's listening. So I don't judge what I'm listening to. I respond to it regardless...I'm coming on xPress, I listen, I respond, and create a post...I feel it's important to do that.*" In comments, she mentioned her own family (12 comments), discussed her experiences with the COVID-19 pandemic (9 comments), encouraged other participants (9 comments), and expressed warm wishes on holidays or congratulatory events (8 comments). For example:

> "I remember when I first started listening to the posts, it was a year ago, and you were doing just what you were doing when you posted this. Taking care of the

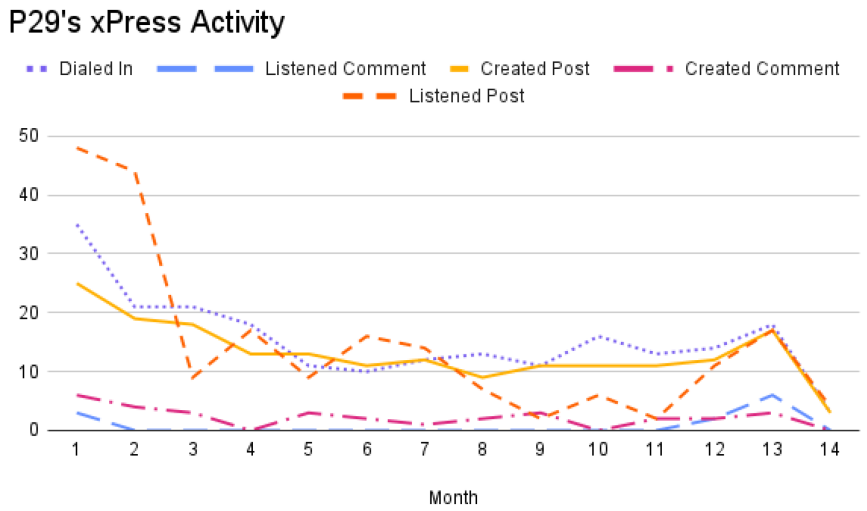

Fig. 8. P29's xPress behaviors over time - primarily posting (posts and comments), more listening than P20.

> vegetables that your son had brought to the apartment. Cooking them, storing them, and just being who you are. The memories that they elicited for you are very special...I'm just so glad that you're still able to do this and to enjoy it. So go on baking that zucchini bread for your son and his wife and family. I can smell it here. Wonderful, wonderful. Take care and happy anniversary. It has been a year since I've listened to you."

In this comment, P20 reflects on hearing another participant's posts over time (another frequent poster) and encourages this participant to continue her cooking hobby.

5.4.2 The Routine Poster. P29 also posted often (185 posts and 31 comments, Figure 8). As a writer $P29_{i\text{-}pre}$ said, (*"I've always done a lot of writing. I used to keep journals and everything. And I've got two college degrees*"), she was excited about using xPress to verbalize her thoughts. Similar to P20, P29 lived in "an apartment complex for seniors only", yet expressed feeling isolated and lonely despite attempts to interact with others:

> "I belonged to a support group for a while, but then after a while I didn't hear anything about it...now with [COVID-19], I mean, I don't get out of my apartment very much...They close off our little community building or community room downstairs where they used to have some activities and like a couple exercise classes and stuff like that. You know, they're not encouraging a of us to getting into groups since [COVID], everybody stays pretty much in their own apartment...I feel left out a lot in the visual world. Because when I came into this building, and even now, I'm the only one, as I said, with a white cane and people just don't understand...When I have [to] go down and do something with the group, I can feel isolated."

In these quotes, P29 describes how her community used to have regular activities that she would attend, yet how the COVID-19 pandemic significantly altered her social interactions with others. Even with these activities, she still felt isolated as she is the only person with vision loss in her residential community. This limited in-person social interaction also affected her online social interaction. During the pre-interview, she described how she wanted to learn how to use an iPhone or send emails and "*tried to think about getting on a computer*" but "*could not find anybody that*

understood how to use the voice part of a program," referring to learning to use a screenreader, and how "*when you have a computer unless you know which key to use and on and on or whatever, you're kind of maybe lost occasionally*". Further, cost affected her online participation. In her nine-month interview, P29 said, "*I dont have the Internet, I also don't have a iPhone. I don't have really any much adaptive equipment. And it's pretty it's a financial issue.*" This quote exemplifies why/how xPress was created [12] - (1) designed with low-cost technologies people already have access to, landline and non-smart cell phones and (2) designed to be an accessible alternative to those who find assistive technologies difficult to use [37].

Motivated by isolation, P29 was excited to use xPress as it provided an outlet for her to be social with other blind and low vision older adults. She thought it was "*nice to be able to connect with somebody that has some of the same issues...I like that kind of support. And I like it when I can learn a little bit from the other people, what their experiences are.*" P29 was one of two participants who signed up for a daily automated reminder call, which helped her remember to dial in, but soon she no longer needed the reminder call, saying "*In the beginning I didn't dial in, I was waiting for the reminder call. But then since then I have been dialing in because I didn't want to wait around for the reminder call, so I've been dialing in.*" Similar to how older adults described the structured benefits of blogging online [10], P29 enjoyed the routine nature of her xPress use, saying, "*I think it helps me right now a lot every day I plan what I'm going to do when I'm a pretty routine person.*" Motivated by her xPress use and former writing background, she also started recording other content:

> "What I have been doing is recording things on a cassette tape... For example, stories, right now, we're trying to do family things. My daughter lives in Illinois, calls me once occasionally and about once a week or so, we do what we are calling family history. Trying to find out where everybody came from and where everybody's going...to develop family history and I thought it was important for future generations."

While P29 enjoyed the disability-related content, she also reflected upon other participants' comment interactions. P29 said, "I don't know if people think I'm saying something good, or bad, or whatever. I don't want to offend anybody...It's been like a one-way street so that I'm not getting that much out of it in terms of connecting with other people very much unless I answer their post." While many participants listened to posts, there were not as many comments as there were posts. P29 tried to encourage people to leave comments on her posts. For example, she posted:

> "I have a cactus plant, which is doing fine, but I have a pothos plant, which is not doing very well. And I don't know what is wrong with it. I don't try to overwater it, and we don't overfeed it. And I don't know what's wrong with it. The leaves are curling. So, if anybody has any knowledge about this type of a plant, and how to care for it, I would really like to hear it."

Despite her attempts, there remained few comments in the community beyond those created by P20 and 29. In her comments on others' posts, P29 often provided encouragement or tips for others experiencing vision loss. For example,

> "I understand your frustration. It's difficult when you lose your vision. I see only light and shadows. I live totally alone, and I try to be as independent as possible. Of course, I cannot do some paperwork. I'm fortunate my kids, my son and his wife, take care of all my paperwork, and my daughter helps with that also. And they all also help me get to doctors and things like that. Other than that, I try to live daily as independent as I can, doing my own cooking, which is chopping up

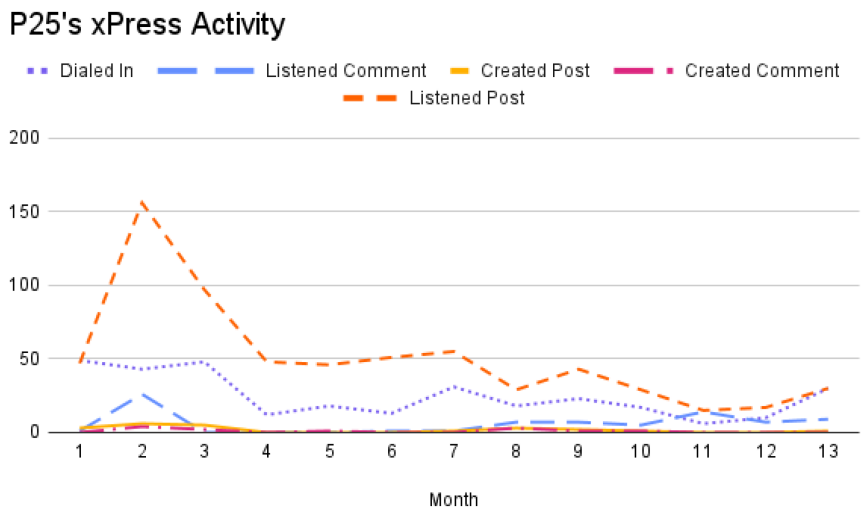

Fig. 9. P25's xPress behaviors over time - frequent listener, some posting.

> stuff, mixing stuff. I've used a rotary mixer, all kinds of stuff. You have to be very careful. I guess my biggest advice is, be as independent as you can and then you will not feel as dependent. It's really important, and try to make as many decisions for yourself as you can, but you've got to be aware of your family. Some decisions have got to be made for the good of all. Take care, be positive, and keep on keeping on."

Instead of comments on individual posts, P29 described wanting a more synchronous feature where community members could "*just pass on opinions, advice, whatever. Sort of like a discussion group.*"

P29's posts and comments were primarily about family, weather, the COVID-19 pandemic, holidays, or daily routine activities like cooking or books. Some of these posts seemed to intersect with her family history cassette project:

> "I remember that doll, taking it on a train trip after the war. When we went, my mother and my sister and I, went by train to see my father who had returned from the war from the Pacific, and was ill, and in a hospital. On that train, it was full. It was like a troop train. It was full of soldiers. We had to sit in the aisle on a suitcase, and some soldiers felt sorry for us, moved over, gave us a seat where they were sitting. Took my little leather doll and played with it, making games and stories of it to amuse my sister and I as time passed. So, the doll brings back some very nice memories. ...Those are just a few of the things that I have treasured from my childhood."

5.4.3 The Cross-Platform Lurker. P25 did not post often (38 posts, 19 comments, Figure 9) but frequently listened to others' posts (630 posts). This behavior reflected his participation offline and in other online communities such as Facebook. Offline, much of his social interaction is mediated through his wife. He said, "*Most of my social contacts are through my wife. She is a much more sociable person than I am. She's always meeting new people, and usually I'm introduced to new people through her.*" Online, he is also an infrequent poster, saying, "*I haven't posted on Facebook a very long time. I mean, like, at least a year, I just comment, or just simply read it move on.*"

His vision affected his online activity. Aligning with prior work on late-life vision loss and declining technology use [37], P25 was once an active technology user but described limiting his online activity after experiencing vision loss.

> "Using technology has always been fairly easy for me until the deterioration of my vision in the last two or three years. I never felt like I had any difficulty with technology. However, now, not being able to read the screen is a real limitation for me that is a challenge"

Vision loss also affected social media use as he said, "*I try to use Facebook, but I have difficulty reading things.*" Specifically, P25 experienced vision loss due to age-related macular degeneration:

> "I have macular degeneration, and that means that when I look at something, part of the image is missing. And so when I look at a word in print, the right end of the word is missing. And so I have to try and guess what the rest of it is, and sometimes it works, sometimes it doesn't. But it's tedious...when I'm communicating with people by email, if they write more than two or three lines, I have difficulty seeing it. And so I usually have to use a magnifying glass to see it, and when possible I use Siri to read it to me. So audio is better than visual for me."

Although P25 used assistive technologies, he preferred audio forms of interaction, such as using a mobile voice assistant for text input (Siri) or search (Alexa). P25 was one of the few participants who had experience reading blogs. He described reading a blog about weather and hurricanes saying, "*I used to read a blog, but that blog isn't available anymore.*" He was excited to use xPress to learn from others, saying:

> I'm no longer able to read and I'm no longer able to drive. I have to be cautious when I'm walking around that I don't stumble and fall. And so these are the kinds of things that I would like to talk to other people about if they have the same kinds of issues.

In interviews, he described listening to a post from one participant who shared about National Federation of the Blind events (e.g., conferences, meetings) and a post from another participant about assistive technologies including visual aids and magnification tools. He appreciated these posts leaving a comment, "*I wanted to thank [participant] for the very useful information she put up about the NFB. And I followed up on the links that she mentioned and found it to be a gold mine of potential information.*"

P25 listened to 630 of others' posts and 86 of their comments, created 38 posts, and left 19 comments on others' posts. Although a frequent listener, he wanted more interaction with others.

> "...One is hoping to get some sort of feedback from other participants, and so if that feedback is not apparent then I think a person, including myself, lose interest in posting because it's like sending a message to the moon or something. It just disappears and you might as well not have made a post because you don't get any comments."

In this quote, P25 specified wanting other participants to post more comments for better "*exchange of ideas.*" He acknowledged that he was "*only listening and not speaking*", yet it was unclear why he decided to primarily listen rather than post other than "*there's no real requirement to do anything.*" Perhaps a minimum requirement to post regularly could have encouraged him to post more, but we adopted an approach similar to other social media sites where we told participants that they could decide how they used the system - posting, listening, or neither.

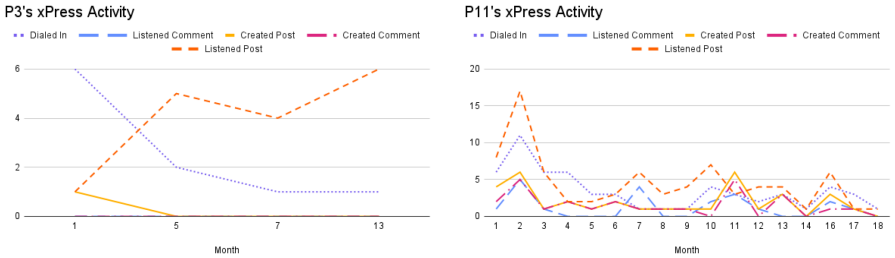

Fig. 10. P3 and P11's xPress behaviors over time.

5.4.4 The Busy Socialite. Participants 3 and 11 were among the least active xPress users. P3 listened to 16 posts and 0 comments, created 1 post, and created 0 comments (Figure 10). P11 also used xPress infrequently but her interaction type varied more than P3; she listened to 78 posts and 20 comments, created 34 posts, and created 26 comments. We include both participants in the same vignette as their reasons for limited use were similar - both (1) were highly active offline in social groups or on the computer and (2) wanted xPress to mimic synchronous communication. By nature of recruiting from the National Federation of the Blind, both participants were members of the same local NFB chapter. For example, P3 said, "*By being active in groups like the NFB. I meet friends because I live in an apartment building so sometimes I meet people there. I'm in a book club.*" P11 was active in a gardening club, her local NFB chapter, bible study, and a tech support group. P3 and P11 were also frequent computer users. For P3, "*it's much easier to email somebody up*". P11, who is low vision, started to take computer classes during the study's duration and use new assistive technologies to help her navigate her computer visually, saying "*because the iPad is a little bit bigger, if I want to see pictures I will use the iPad rather than the iPhone*" ... "*I had this thing called the Pebble. It's a small electronic magnifier.*" Although both were infrequent xPress users, they had different living structures. P3 lived in an apartment community and P11 lived by herself with no family nearby, which could have impacted their feature use variability. Interestingly, P3 noticed "*that the person who's on it is very lonely and so for that you know, so I hope it's helpful to her*" and that xPress would be ideal *"for people who don't have a way to connect with other people."* As such, she speculated that her offline social life contributed to her limited xPress use.

Additionally, both participants wanted xPress to mimic synchronous, in-person conversations. P11 described what she envisioned saying, "*I wonder if you could have an hour set aside for a few of the people to actually communicate. I don't know. Something like that to actually talk to each other.*" P3 raised a similar idea about how to have more private conversations or "*direct answers*" saying, "*So if I found someone who I thought was particularly interesting it would be nice to have a way to go to their extension or something.*" Although P11 generally enjoyed listening to others' posts and P3 saw the value in xPress for people who either are lonely or socially isolated, they wanted xPress to offer quick, conversational forms of interaction in addition to asynchronous components. A lack of synchronous options contributed to their low xPress use.

5.4.5 The Visual Expertise Seeker. Participant 33 did not withdraw from the study but did not use xPress. In his 3-month interview, he described wanting "information on how to make the calls." Although a researcher reviewed this information in the pre-interview and in the 3–month interview, he chose to not use xPress during the one-year study. In the post-interview, he described how he prefers visual online communities. For example, on Facebook he likes "*to see pictures that the kids post. I don't really do any posting on it. Very, very, very seldom, but it's a nice reminder of somebody's birthday or pictures that people post onto it.*" He expected xPress to be a "*system that is more visual, that A, I can compartmentize [sic], to be able to see what might be interesting to me. And B, that I can look at the mannerisms of how it's being presented.*" These quotes show how P33 (low

vision) has some visual acuity and prefers online communities that are quick for him to scan and see what might be of interest. Aligning with prior work [10, 49], he prefers to engage online with this visual acuity rather than use audio-based online communities.

In the post-interview, P33 also described how he wanted topics to be created by subject-matter experts. He did not like opinion-based content because "*typically nothing affects me [...] To listen to blogs of what people think, without discriminating, it's not useful to me*". Instead, he wanted people to post "*after they've done some homework on things.*" In the post-interview, P33 described how he preferred engaging with journalistic content or objective content created by experts who fact-checked content, similar to the news or TED talks. Once he learned that the xPress community would include posts by others in the study, he was no longer invested in dialing into the system. Similar to P3 and 11, he also described being "*too busy to be using the interactive system*" as he had a job "*doing consulting work, working on projects.*" P33's experience signals that people may not engage in a voice-based community if its synchronicity modality does not align with their preferences, the content has not been fact-checked, and it is not easy to fit into one's busy schedule. Future work might address these concerns by designing cross-synchronicity voice communities with a screen option, separating community content into objective/fact and subjective/opinion, or focusing on members who are more socially isolated.

6 DISCUSSION

Returning to our initial research goals, we present empirical data on how blind older adults use the xPress voice community. Survey trends show xPress use had mixed effects on two measures of social well-being - loneliness and perceived social support. While not statistically significant, loneliness decreased sharply in the first six months of use and perceived social support increased sharply in the last six months of use. Interview and post data shows how use included a range of posting and listening behaviors, motivated by varied voice community goals. In this discussion, we reflect on these roles and how they align with envisioning future voice communities for blind and low vision older adults. We focus on two opportunities for voice community design that more active and less active participants described for supporting more meaningful voice community interactions - (1) how to improve content relevancy to strengthen relationship development and (2) supporting participants' routines through mixed synchronicity voice communities. Designing for these goals could also benefit other historically marginalized communities or those seeking to engage socially by voice. Lastly, we reflect on our original xPress design and use, discussing how this field deployment differed from our original deployment in 2016.

6.1 Developing Relationships through Relevant Content

Participants used their posts and comments to disclose information about themselves and seek disability advice. This behavior could suggest that xPress is most useful as a tool to share about disability, reframing xPress away from a broad community to a specific community of practice. However, participants also frequently posted about their hobbies (e.g., cooking, gardening, wrestling). Throughout the study (e.g., pre-interviews, post-interviews), participants shared that visual online communities were inaccessible. Therefore, they sought interactions that one would expect from a mainstream online community where they could find posts about topics that interested them, beyond disability. Specifically, they wanted to hear more relevant content and have better ways to get to know other participants. Some participants were frustrated by listening to a few power users as these users often posted on topics that participants found uninteresting or unengaging. Prior work on online communities suggests community size, membership boundaries, and design affordances affect how people develop relationships [43]. While we drew from this work to design

xPress (e.g., including a commenting feature, providing interaction cues), we note that doing so by voice can be challenging.

Designing for relationship development might include allowing participants to search for content or users that align with their interests, using a ranking algorithm to present relevant posts, or including private messaging features. The first two options focus on discovering relevant content, whether based on user selection or ranking algorithms. However, discoverability is a known challenge with voice and livestreaming communities as people may not know what to search for, or presenting too many options can be cognitively burdensome [39, 50]. As a result, we decided to mimic traditional blogging platforms for presenting information in reverse chronological order, which led to xPress playing potentially irrelevant content first and participants typically hearing content from frequent posters. Instead, we recommend that designers **build voice communities using community participation data to modify how content is presented**. For example, if there are a few users who are posting most of the content, perhaps a voice community could use a ranking algorithm to present content based on users' previous engagement. If a user frequently comments on posts about disability, content related to disability could be ranked higher and presented more often. On the other hand, if there is a more equitable distribution of voice community members creating content, a reverse chronological algorithm could work well. In this way, there would be fewer opportunities for a small group of participants to dominate conversations in voice communities.

Participants also sought ways to develop relationships with individuals outside of the group posting/commenting format. Screen-based online communities offer ways for their members to send direct messages to engage in 1:1 interaction. Voice community designers could also consider how **adding individual or small group messaging could help members develop relationships**, particularly as voice communities scale to hundreds or thousands of users. For example, several participants posted about cooking. A voice community could infer the content topic and match individuals to pairs or groups to discuss this content. However, voice community designers must carefully manage doing so in ways that do not create harmful echo chambers (e.g., politics, religion).

As with existing screen-based online communities that offer microcommunity customization and community moderation options (e.g., Discord, Slack, Reddit), voice communities could use role behavior to allow its members to manually adjust community norms or customize automated approaches. Above, we provide examples of how members' roles could affect transitions to synchronous voice communities or creating small groups for niche topic discussions. We encourage future work to understand how implementing relationship development and routine support features scale to larger voice communities.

6.2 Mixed Synchronicity Communities to Support Routines

From analyzing how the top two posters used xPress, we learn about their goals for using this voice community as part of their routines. Reminder calls helped them to develop routine xPress use. However, the asynchronous interaction style made it difficult for them to connect with other xPress users. On one hand, the small number of active users may have contributed to participants wanting quicker and more synchronous interaction. On the other hand, the scale of the community could have made it easier to listen to new content from other posters. Overall, routine listeners wanted better opportunities to interact with others synchronously. Prior work has discussed challenges with solely synchronous or solely asynchronous online communities [41, 50], yet combining them could be helpful to users who derive benefits from each option.

As such, we recommend that voice community designers explore options for mixed-synchronicity communities that provide asynchronous and synchronous forms of engagement. Open questions remain about (1) how to support both interaction modalities in a voice-only

community at scale and (2) how to add features without increasing the cognitive burden for users. For example, xPress could be programmed to announce weekly synchronous sessions where all participants can speak to one another at a specific time. Although similar to a phone call, connecting these synchronous experiences to xPress community users would maintain meaningful contextual information such as user name and post content that could be lost if people dial into a different system. With a larger size community, these synchronous sessions could be scoped to topics that users post, listen to, or comment on frequently. For either option, conversational patterns like turn-taking could be challenging without visual cues. In screen-based online communities, features like a mute/unmute icon can signal when someone is planning to speak to avoid cross-talk. While prior work describes gesture-related conversational patterns with people with visual disabilities [30], open questions remain on remote, group-based conversational patterns for blind people. In summary, researchers and designers could implement synchronous interactions in asynchronous voice communities by including weekly conversation opportunities for small communities, topic-based conversations for large communities, and non-visual turn-taking mechanisms for varying group sizes.

6.3 xPress: Then and Now

Lastly, we would like to reflect on xPress design and use over time. We acknowledge that there are similarities between this field deployment and our previous deployment [10]. Specifically, participants continued to connect with new peers on disability-related topics, valued the personal nature of interacting through human (rather than synthetic) speech, wanted more opportunities for interaction, and wanted a better way to organize content. However, there were also some notable differences, including system design, study duration, sample size, intent, and findings.

In the previous study, there were several participants who wanted more cues about their audience. In the current study, we modified xPress's design to play how many community members posted *and* listened to posts. Next, the original field deployment took place over 10 weeks, compared to the current study, which included a one-year deployment for intervention condition participants. This longer duration helped us better study use over time and mitigate novelty effects. Next, we previously deployed xPress with seven Blind and low vision older adults (one withdrew from the study). In the current study, 21 Blind and low vision older adults were randomly assigned to the intervention condition and had access to xPress (six withdrew from the study). Although there was some dropout, 19 participants used xPress at least once. As such, we were able to observe greater variation in the types of activity and describe participant roles through vignettes. These vignettes are the first to categorize voice community users *and* infrequent or non-users, underscoring the value of understanding a range of activities and rationale for non-use in online community design [3, 13, 14]. From recruiting a larger sample size and including a control condition, we were able to observe how xPress use affected two measures of social well-being: loneliness and social isolation. Although these differences were not significant, they suggest that voice communities may mitigate loneliness in moments of extreme isolation. Future work could seek to understand voice community use with a more socially isolated sample. Overall, having a larger sample size allowed us to go beyond describing affordances of voice communities and an exploratory deployment to understanding activity with more nuance including over time and by participant, and including contextual factors like community engagement and technology use over time.

We also observed differences in our findings. In our previous study, we (1) found that human speech afforded a more emotional experience than synthetic speech, (2) learned how non-use of our public-facing social media component and distancing from non-disabled content signaled values and norms around community expectations. In the current study, we also learn about non-use, but specifically how non-use was connected to relationship development expectations. As such,

we recommend design features (private messaging, synchronous options) that could improve content relevancy and, in turn, ease relationship formation. We also learn *when* voice communities could be effective at mitigating loneliness, namely at the beginning of extreme isolation periods.

7 CONCLUSION

Voice-based online community use and design is a growing topic within computing research. Prior work focuses on quantitative descriptions of voice community use or qualitative descriptions of short-term use. We build on growing work calling for accessible alternatives to screen-based communities and extending voice technology use beyond information seeking to present a one-year study of xPress, a voice-based social community. Our findings provide rich qualitative data describing how blind and low vision older adults use xPress to support their social goals at a time when many were extremely socially isolated. We present vignettes of participants' use including those who posted and listened to content and those who did not, underscoring the importance of understanding varying user roles within a voice community. We discuss how researchers and designers can learn from blind and low vision communities to facilitate non-visual relationship development and how to support mixed-synchronicity interactions in voice-only communities.

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