

Family Portals: Connecting Families Through a Multifamily Media Space

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ABSTRACT

Video conferencing allows distance-separated family members to interact somewhat akin to being together at the same place and time. Yet most video conferencing systems are designed for phone-like calls between only two locations. Using such systems for long interactions or social gatherings with multiple families is cumbersome, if not impossible. For this reason, we wanted to explore how families would make use of a video system that permitted sharing everyday life over extended periods of time between multiple locations. We designed a media space called Family Portals that provides shared video between three locations and deployed it within the homes of six families. Results show that the media space increased feelings of connectedness and the focus on a triad, in contrast to a dyad, caused new styles of interaction to emerge. Despite this, families experienced new privacy challenges and non-adoption by some family members, not previously seen in dyadic family media spaces.

Author Keywords

Media space, domestic, families, awareness, video.

ACM Classification Keywords

H5.3. Information interfaces and presentation: Group and Organization Interfaces – *Computer-supported cooperative work*

General Terms

Design, Experimentation, Human Factors.

INTRODUCTION

Many families are separated by distance due to job or educational opportunities in different cities or simply because of lifestyle preferences. Despite this, most family members still want to remain connected and aware of each other's lives [13,21,24]. For instance, grandparents want to see their grandchildren grow up and parents want to know about the well being of their adult children [1,12,14]. People also typically want to participate in multifamily

gatherings such as holiday events or birthday parties, but this is difficult to do unless one is able to travel.

Video conferencing (VC) is one technology that is increasingly being used by families to stay in contact over distance [1,12,14]. However, the inclusion of multiparty video calls in VC systems—connections between more than two sites [6]—is still in its infancy. Multiparty video calls are important for they can allow people to connect with more than a single family at one time, thereby modeling face-to-face situations even more. Yet there are also potential challenges. We do not yet have a good understanding of how such systems can support family routines, including varied privacy expectations, sharing needs, and relationship dynamics [27].

Given this, we wanted to see how we could allow multiple families to easily connect over distance with a VC system to maintain an awareness of one another, participate in shared activities, and, ultimately, feel connected by actually seeing each other. Here we turned to media spaces given their potential to easily fit into domestic life and permit long-term sharing [13]. Media spaces have been studied for dyadic (two family) connections and shown relative success [5,9,28]. What is not clear is if and how media spaces might extend beyond this to support multifamily connections.

As a first step in this direction, we explored three-way connections or triads, as the simplest multifamily case. This builds on our previous work on the Family Window [13] by moving from dyadic to multifamily connections. We designed a three-way domestic media space called Family Portals and evaluated it through a field deployment in six families' homes. Our results illustrate the ways in which a multifamily media space changed family interaction dynamics to increase feelings of connectedness and awareness and the design features that led to this activity. We also describe the challenges faced by families in terms of privacy and non-adoption by certain family members.

RELATED WORK

Awareness of Family and Friends

People have a strong need to gather an awareness of multiple family members, loved ones, and friends' *activities, locations, and status* (e.g. health) [21,24,27]. Knowing this information helps people feel close and connected to others [21,24,27]. Preference for this

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awareness varies though. People like to know very detailed information about the people they live with, labeled *home inhabitants*, and those with whom they have a close relationship, called *intimate socials* [21]. Yet they desire less information about their extended contacts [21]. This information is shared using everyday technologies such as email, the telephone, or instant messaging when people are unable to meet and share information in person [21,27].

Researchers have also investigated new systems directed specifically at supporting this type of awareness sharing. Several focus on dyadic exchange between only two households [5,20,24]; however, it is not clear if and how they systems might extend to multifamily sharing (the focus of this paper). In contrast, there are also systems that directly focus on multifamily awareness. For example, messageProbe [10] and Wayve [17] supported multifamily drawing and messaging. While beneficial, neither system allowed families to participate in shared activities like they might in face-to-face situations or over VC systems [12,13].

In recent years we have seen people migrate to using social networking sites such as Facebook or Twitter to remain connected to a multitude of friends and family members all at the same time [2,11,15,16]. Studies of college students showed that users can, in theory, keep track of hundreds of contacts through one system by monitoring status messages, wall posts, and uploaded media, a process labeled as *social searching* [16]. Again, this is beneficial, however we hypothesize that such sites do not provide family members with true feelings of intimacy and closeness given the large number of contacts that one can follow and the broadcast nature of the information being exchanged.

Video in the Home

VC has also been explored in the home as a technology for supporting family communication and awareness. Studies have shown that VC allows families to easily communicate and share activities in real time and increase feelings of connectedness [1,12,14]. Yet VC systems are not typically used without challenges. Ames et al. [1] describe the work that goes into a video call: *technical work* to schedule and establish calls, *presentation work* to make family members presentable, *behavioral work* to manage children's behavior during video calls, and *scaffolding work* to aid children in participating in the video call. This additional "work" can make existing VC systems difficult for families to use.

Recently media spaces have been studied in terms of their ability to support dyadic family connections [13,23,28]. Here we differentiate between two types. First, there are media spaces used for interactions over short durations, akin to phone calls. In this category, we place media spaces like the Share Table [30] and Family Story Play [25] which both aim to support specific activity instances (e.g., reading, playing). Second, there are media spaces that are left

always-on to provide awareness over time and sharing everyday life. Our interest falls in this category. Always-on media spaces have the potential to reduce the technical work [1] needed to establish connections since connections are ongoing. This also means that extended activities such as social gatherings are easily shared [13].

The closest media space to our current efforts is our previous work on the Family Window [13], an always-on dyadic video media space. Using it, families were able to gain availability awareness in order to time interactions and subsequently shared daily activities [13]. The Family Window saw very few privacy concerns arise, which is surprising for always-on video broadcasting from the home [13]. We found this to be true because of the close relationships shared by participant households [13].

Multiparty Media Spaces in the Workplace

Media spaces have been studied in the workplace for over two decades as a means to promote awareness and communication between non-collocated colleagues [3]. The first media space at PARC supported only a dyadic connection; however, several systems following on from this investigated multiparty connections. First, multiparty media spaces were designed to support workplace awareness and informal interactions. For example, Portholes showed updating video snapshots of media space participants and allowed users to send *targeted* messages to individuals or *broadcast* messages for all [8]. Community Bar [19] extended this to support the creation of ad-hoc groups within a larger group setting.

Second, multiparty media spaces were used for collaborative work and real time meetings between colleagues. CAVECAT [18] allowed users to interact with four colleagues simultaneously by viewing four video feeds on a split screen. Hydra [25] replaced each participant in a meeting with a video surrogate created by a camera, monitor and speaker. LiveWire [26] used voice activation to determine who was speaking and automatically represented the speaker in a "full screen" mode. According to Buxton et al. [6], multiparty VC systems in the workplace were limited in their ability to support parallel conversations and in allowing participants to selectively listen to different, parallel conversations.

This paper builds on the history of multiparty media spaces in the workplace by exploring them in the context of the home and domestic life. Here we explore targeted *vs.* broadcast messaging, full screen *vs.* screen split viewing, and varying group dynamics created by multiple families.

DESIGN OF FAMILY PORTALS

Our first step in this exploration was to design and implement a multifamily media space. We call this media space Family Portals (FP) as it contains "portals" into distant families' homes (Figure 1).

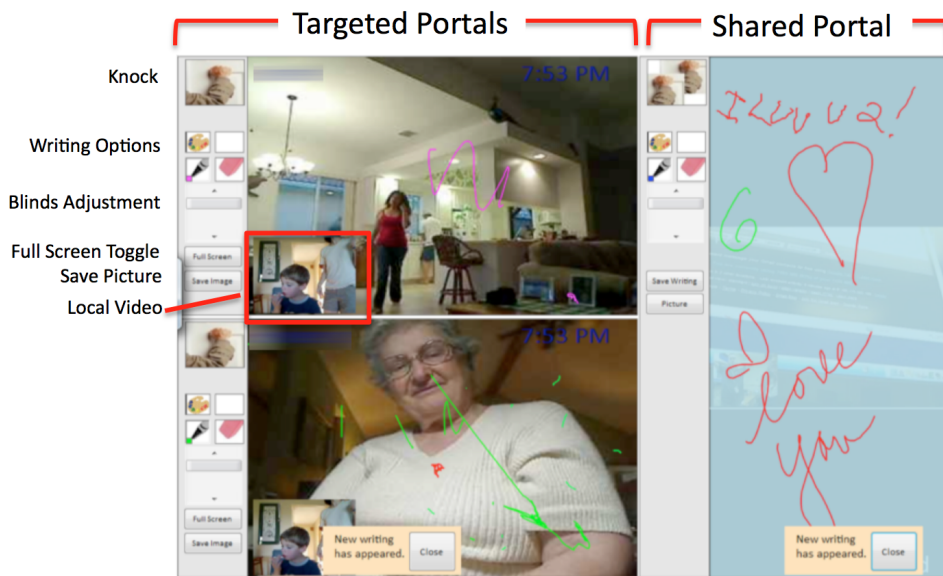


Figure 1. Family Portals.

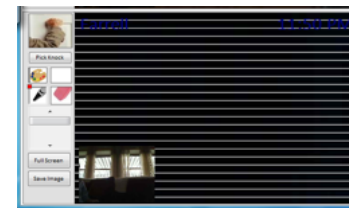


Figure 2. Blinds halfway down at night in one home.



Figure 3. Full screen view.

Basic Design

FP is an always-on media space that provides a continuous video connection between three households. We omitted audio because we wanted to focus our investigation on video for awareness and focus on asynchronous interaction (eg. writing). Although audio is a rich medium for communication, studies have shown that audio is often more privacy intrusive than video [9,13]. As such, we focused on features that were potentially less intrusive.

FP was prototyped on a touch and pen-sensitive Tablet PC with an external webcam to simulate the idea of it being a dedicated information appliance as opposed to a computer used for multiple tasks. The dedicated device means that FP can be easily moved throughout the home depending on where family members want to share activities.

Although FP is designed to connect three families, we did not expect the families to have the same relationship with each other. For instance, a daughter connecting to both her *mother* and *sister* might not want to share the same amount and type of information with both of them. Thus we decided to provide two types of interactions—*targeted interactions* and *shared interactions*—to allow families to share information in a dyadic manner vs. a triadic manner. For this reason, as seen in Figure 1, the screen is divided into two areas: Targeted Portals on the left, and a Shared Portal on the right. We describe these next.

Targeted Portals

The left side of the screen in Figure 1 shows two Targeted Portals (top and bottom), one for each family that a local user is connecting to. The Targeted Portals are intended to allow families to interact and share information with *one* of their two remote families in a dyadic manner. This is similar to the concept of *directed* in Portholes [8]. Interactions within each Targeted Portal affect only the

remote family that is associated with that Portal. Each Portal is identical in terms of its features.

Always-On Video. The main portion of each Targeted Portal shows video from the remote family’s home. Video is transmitted over the Internet at a rate of one frame per second with 320×240 resolution, using a client-server architecture. Latency issues made it difficult to maintain a continuous connection with higher frame rates. The bottom left corner of each Targeted Portal shows the local family’s video feed as seen by the remote family. This provides feedback of what is shown of one’s home. Family members can obscure their video feed, as seen in Figure 2, by adjusting slate blinds using a slider on the left side of *each* Targeted Portal. This allows families to provide a different view for each remote family, if they so desire. The slow frame rate also creates an unintended privacy filter by not broadcasting in full fidelity.

Initiating Interaction. Studies of the use of video conferencing in the home noted that families need an easy and unobtrusive way to determine if the distant family is available for a video chat [12]. Users can click a *Knock* button in the top left corner of the Targeted Portal and this produces a knocking sound in the local and remote home.

Messaging. Users can leave handwritten messages for specific families by writing on top of the video in each Targeted Portal using either the stylus or one’s finger. Only the target family sees the writing; thus, it is a private writing space for the two families. A notification appears in the remote home when a new message is written. Users can pick ink colors and erase writing using the icons on the left side of the Portal.

Full Screen. We also expected families to want to focus their attention on one remote family at a time, e.g., if the third family isn’t home. To enable this, users can toggle between *Full Screen* and *Split Screen* views by clicking a

button on the left of the Portal. In Full Screen mode, the Portal expands to cover the entire screen, as shown in Figure 3. The third family's video is minimized and displayed at the bottom right corner.

Shared Portal

The right side of Figure 1 shows the Shared Portal. It provides shared interactions intended for the entire triad. Dourish et al. [8] called this type of interaction *broadcast*, where all users of the system have access to all information. The main portion of the Shared Portal displays a whiteboard to support triadic interactions. Users can write on it to leave messages for *both* remote families. A multifamily knocking feature lets a local family knock on both remote families' portals simultaneously. The Shared Portal also contains a slider that will adjust the blinds for the local family's video. Blinds adjustments performed here affect the video that is transmitted in *both* of the Targeted Portals. This allows families to quickly show the same video feed to both remote families.

Comparison to Existing Systems

The design of FP draws from existing systems and extends them to support multifamily interaction in a media space. Family Window's knocking feature [13] and CoMeDi's blinds [7] are extended to include multifamily versions of these in the Shared Portal. CommuteBoard, messageProbe and Wayve [9,10,17] all provided a shared writing space like our Shared Portal. However, we extended this by also providing a private message board for each family in the Targeted Portals. The appropriation of these features in combination with our understanding of domestic communication, existing domestic media spaces, and multiparty workplace media spaces led to the design of FP.

FIELD EVALUATION OF FAMILY PORTALS

Following the design and implementation of FP, we conducted a field evaluation to learn how families would use the system in their daily lives, what communication and awareness practices would emerge, and what privacy concerns they would face. We recruited families using snowball sampling and advertisements in local mailing lists and web sites. Potential participants completed a screening questionnaire that asked about their communication with extended family and whom they wanted to connect to using a futuristic VC system. We selected six families (two triads) from the USA who would provide interesting and different relationship dynamics. Participating households were composed of young families, blended families, a divorcee, and retirees. Families received gift cards for participating.

Initial Interview and Setup. We first visited each family's home and interviewed them about their existing communication practices with their extended family and, more specifically, about the families they were going to connect with using FP. One family lived outside driving distance and was interviewed using Skype. At the conclusion of this interview, families were walked through

the initial setup of FP on their home wireless Internet connection, asked to select a location for FP and use it as they naturally saw fit. All families were given a Tablet PC with FP application, a stand for the Tablet PC and webcam for the duration of the evaluation. The initial interview lasted 2 to 3 hours and setup took 1 to 2 hours.

Deployment and Interviews. All six families had FP within their homes over a period of eight weeks. We visited families throughout the deployment and conducted six semi-structured contextual interviews with them during this time period. The one distant family, again, was interviewed using Skype. Adults were interviewed individually (when possible) and children were interviewed with parents present. Questions focused on families' usage of FP, changes in communication, connectedness and awareness with remote families, as well as privacy concerns. Interviews occurred weekly with the exception of weeks two and four; technical difficulties discussed below caused families to not be connected with the system during these two weeks. Each family was given a diary for self-reports between interviews. We also sent emails and phoned between interviews to check for technical difficulties and to help troubleshoot problems. After the final interview at the end of eight weeks, we removed FP from families' homes.

Post-Deployment Interview. We conducted a final interview two weeks after FP had been removed from the families' homes. Questions focused on communication, connectedness and awareness of remote families compared to the eight weeks families had FP in their home.

Data Collection and Analysis. Usage data was collected through the interviews as well as self-reports in diaries given to each family. The limitation of interviews and self-reports is that participants may self-censor responses and omit details. We were able to sufficiently overcome this limitation by comparing responses between family members. All interviews were audio-recorded and handwritten notes were taken to aid analysis. In total, we acquired data from approximately 108 hours of interviews and observations across all six families. Usage of features (e.g. blinds, full screen) was logged throughout the study. Snapshots of writing on FP were also taken by the system. We used open coding to analyze the interviews and diary entries and generated codes that reflected a variety of usage patterns. These codes were combined to create themes that are reported in our results.

Caveats. Although FP was placed in families' homes for eight weeks, families were only able to use the system for an average of five weeks. Despite rigorous testing before deployment, numerous technical issues related to connectivity arose. Such issues have also been reported in other field evaluations in the home [9,24]. Nonetheless, we found that five weeks of usage was sufficient for participants to overcome novelty factors, develop patterns of use, and incorporate the system into their daily lives.

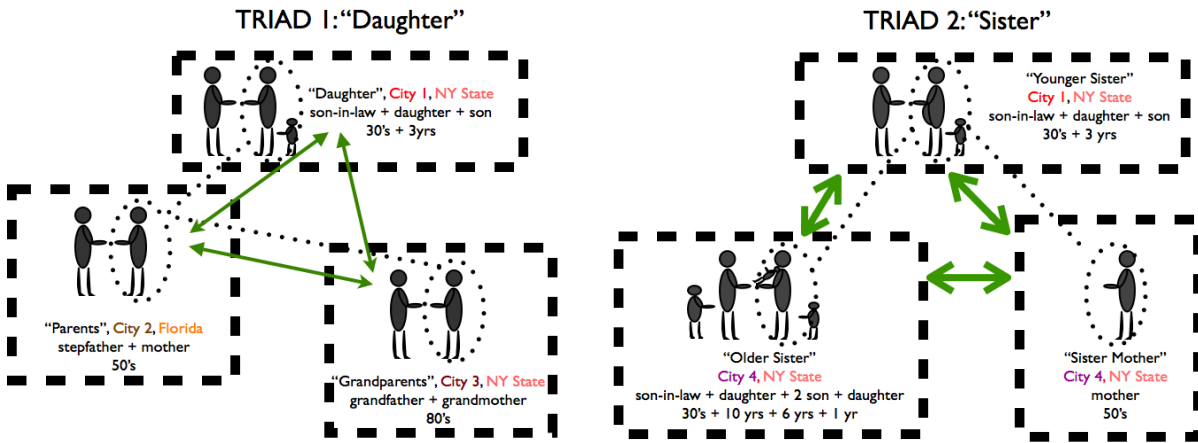


Figure 4. Participants in Triad 1 and 2. Primary users are circled and connected with dotted lines. Numbers refer to ages.

Participants. Figure 4 illustrates our participant families. Relationships are described from the point of view of the *seed family* (e.g., “Daughter”, “Sister”) who responded to the advertisement of the study. A seed family is connected to two *remote families*.

Triad 1 consisted of the *Daughter family*, composed of two parents and a 3-year-old son. They used FP to connect with the wife’s mother and stepfather who we call the *Daughter Parents family*, and to her maternal grandparents who we call the *Daughter Grandparents family*. All three families placed their FP in their family room.

Triad 2 consisted of the *Younger Sister family*, composed of two parents and a 3-year-old son. The wife in this family was in the 8th month of her pregnancy when we started the field evaluation. They were connected to the wife’s mother who we call the *Sister Mother* and to her older sister and family who we call the *Older Sister family*. Younger Sister placed her FP on their dining table, Older Sister in the home office and Sister Mother in her family room. All six families had experience using dyadic communication such as email, telephone, video chat and IM but none had experience with multiparty interactions with these tools.

RESULTS

We begin by describing the communication patterns between families prior to using FPs. Next we describe the interesting patterns of usage that occurred with FP and discuss design features that led to and supported these routines. We also discuss the features that did not meet users’ needs, thereby causing workarounds to be used. Given the similarity between FP and the Family Window [13], we directly compare usage between the two systems.

Communication Prior to Using Family Portals.

Triad 1. The wife in the Daughter family and her mother were very close to one another. They phoned and emailed almost daily. She also used Skype every weekend to allow her parents to interact with her son. Although she lived within an hour’s drive from her grandparents, she only

communicated with them over the phone once a month, but felt guilty for not communicating more with them. The wife in the Daughter Parents family was the oldest daughter of the Daughter Grandparents. She phoned her father every morning while commuting to work and spoke to her mother once a month. The Daughter Grandparents did not like to phone their children or grandchildren because they knew they had busy lives and did not want to disturb them. They also preferred face-to-face interactions over the telephone.

Triad 2. The wife in the Younger Sister family and her mother spoke on the phone once a week and conversed via text or IM messages daily. Sister Mother lived in the same city as the Older Sister family, met them in person at least three times a week, and used IM daily. Younger Sister and Older Sister did not communicate much due to scheduling difficulties. The sisters spoke on the phone once a month and emailed or IM once a week. Both sisters wanted to communicate more with each other.

Basic Usage and Reactions

Families left FP running continuously throughout the field evaluation with the exception of downtime due to technical difficulties. Over time, FP became the focus of communication between most families. In comparison to dyadic communication, families said they preferred the three-way video provided by FP because they could connect to more families simultaneously and if one family was not available, the other would be. This provided ample opportunities for interaction. Families reported that their communication (using FP and other technology such as phone) increased during the study. Once FP was removed, communication returned to its previous pattern and families felt less connected as they could no longer see each other.

Usage and Non-Usage

The primary users in each triad were the women of the families. In Triad 1, this was the daughter, mother and grandmother. In Triad 2, it was the younger sister, older sister and their mother. This is consistent with the findings

from [9], which show women are generally the “household communicators.” It is also important to note that one woman in each triad answered the advertisement for our study and determined who they would like to be connected to using FP. Surprisingly, the husband in the Daughter family (Triad 1) was also a heavy user of FP. He worked from home on a daily basis and liked having people to interact with while his wife was at work and his son was at daycare. Secondary users in each household were the families’ children. Younger children (3 years and younger) used FP under their parents’ supervision for the first week and then on their own when they wanted to after that.

One might expect that certain individuals may not like always-on video being broadcast from their home. Findings from the Family Window showed this type of privacy concern to be of little issue when families shared a close relationship [13]. For these reasons, we were both surprised *and* not surprised, to find out that not all members of our participant households used FP or even wanted it in their home. Three adults and one child (aged 6) did not want to use FP or did not want to be captured in the video feed. We saw four reasons for this:

Intrusion. The husband in the Younger Sister family and live-in boyfriend in the Older Sister family avoided FP because they did not want to be seen by their in-laws all the time. They tried not to be captured in the video feed or moved the camera to face a different direction when in the same room as FP. Although both of them were cordial with their in-laws, they did not want to see them all the time and thought the always-on video was intrusive.

“It is like someone is staring at me all the time. Even if no one is there, I still think someone is staring at the back of my head while I am on the computer [FP is placed opposite the computer]” – Interview with Boyfriend in Older Sister family

Fear of Technology. The grandfather in the Daughter Grandparents family did not use FP because he was intimidated by the technology. After technical problems with the system, he was afraid to use FP because he was concerned he “might break it”. He did, however, occasionally look over his wife’s shoulder while she interacted with the remote families. Over time, he overcame his fear and sporadically “peeped,” as he called it, into FP to see the remote families but he never interacted.

Satisfaction with Communication. The grandfather in the Daughter Grandparents family also told us that he was satisfied with the amount of communication he had with the remote families and did not need additional communication using FP:

“When you have 5 children, 7 grandchildren and 12 great grandchildren, you have a lot of family to keep up with.” – Interview with Grandfather from Daughter Grandparents family

Lack of Closeness. The only child who did not use FP was the second child in the Older Sister family. He was Older Sister’s stepson who lived with them during the weekend

and with his mother on weekdays. To him FP was a connection to his *stepmother’s* family who he met a few times a year and was not close to.

Despite the non-adopters, we saw heavy usage by the primary and secondary users. We describe this next.

Sharing Everyday Life and Providing Awareness

The most prominent pattern of usage for FPs across all six families was to share information about each other’s daily life. This emerged in two ways. First, families used the *video* feed to share information and participate in each other’s daily activities. For instance, Older Sister moved FP to their kitchen one night, to allow her mother to watch her and her son work on an art project (Figure 5). Younger Sister, on the other hand, used the video to show her mother and sister the progression of her pregnancy. Because the video was always on, it was easy for her to walk up to the display and show her baby bump to her remote family.

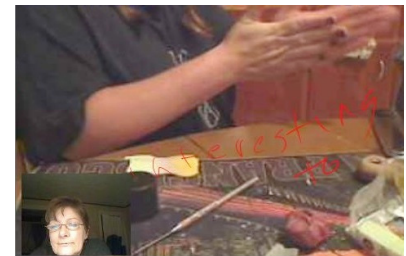


Figure 5. Sister Mother watching Older Sister and her son work on an art project.

“They like seeing how big I am getting.” – From Interview with Younger Sister

This type of sharing was also found with the Family Window [13] due to the always-on nature of the video feed.

Second, families used the shared whiteboard to share information about their *location*, *activities* and *status*, all awareness types articulated by [21]. This type of sharing was done by adults in the families. In terms of *location* and *activities*, this meant, for example, leaving messages saying where family members were going and what they planned to do that day. For *status*, it meant describing how their day was going, how they were feeling, etc. For example:

“Hi [Younger Sister]. How are you doing? What’s going on? I’m seeing a Doc for gall bladder issues too. Had a sonogram. Waiting 4 results.” – Older Sister’s note on shared whiteboard to Younger Sister

When asked about this sharing, Older Sister commented that she would not normally share this level of detail with her sister because, by the time they had their monthly phone call, she would have forgotten the specifics. Other family members said this type of information was typically not shared with distant family members using other technology (e.g., phone, email) because it was thought of as mundane and not of interest to others [27]. The fact that it became something they *did* talk about suggests families do place value in knowing this level of detail. The increased *frequency* of information exchange led to the adults in all six families (except non-adopters) feeling more connected.

Playful Interactions

Families also had fun with FP by engaging in playful activities. This was surprising since it was not found with the Family Window [13]. Both the video feed and writing capabilities supported families' playful activities. They drew pictures, doodled, made faces, and simply had fun with each other. For instance, Older Sister who was an artist regularly drew pictures of sunsets and other scenery. The grandmother in the Daughter Parents family drew planets for her grandson who was learning about the solar system. Such activities were made possible by the shared whiteboard and multiple ink colors that families could use.



Figure 6. Children in Triad 2 interacting.



Figure 7. Sister Mother interacting with grandson.

The writing feature also provided a fun and easy way for younger children to communicate via drawings. Children in the families, such as Younger Sister's 3-year-old son, used FP to interact with his 10-year-old cousin (Older Sister's son) by drawing (Figure 6). This is similar to the way families used Wayve [17] for play, however, families said the video feed in FP enhanced this experience by allowing family members to *see* each other while interacting. This type of interaction was especially important for children as it kept them engaged long enough to interact with distant family members. This provides one solution to the problem of keeping children engaged while using VC systems [1].

Playful activities were also common between grandparents and grandchildren. For example, Sister Mother drew pictures and made funny faces while interacting with her grandson (Figure 7).

"My nanna [Sister-Mother] makes faces. She was a walrus that day. I draw on her face and she looks funny. I also drew octopus"
– Interview with Older Sister's 10-year-old son

Synchronous Communication

We had designed and expected that FP would be mostly used for ambient awareness and asynchronous interactions (e.g., "checking in" on families every now and then), especially because the device was always running and available. Indeed we saw this, as previously described. However, more surprisingly, we also found that families would move into episodes of synchronous interaction where FP became the focal point for real-time communication.

Dyadic Communication

Despite FP being designed for a triad of families, as one might expect, there were many occasions where only two families were around and available for synchronous communication. Thus, a prominent use for FP was dyadic

communication. These sessions were not meant to exclude the third family but typically happened serendipitously or were scheduled based on two households' availability.

There were three patterns of dyadic communication. First, families used the video in FP to see each other and supplemented the video with a phone call. This is similar to the way families used the Family Window [13]. However, the addition of a third family in the media space led to members of the third family inadvertently feeling left out on occasion. For example, the grandmother in Triad 1 occasionally saw her daughter and granddaughter talking to each other on the phone. She sometimes tried to inconspicuously get their attention by waving, but they were usually too engrossed in their conversation to notice her. This made her feel left out. This suggests design features to notify families who are conversing that another family is around and possibly available for communication.

Second, families chose to use the shared whiteboard for synchronous "chats". This is similar to findings from the Family Window [13] where families had synchronous chats by writing on the video feed. For example, the daughter in Triad 1 and her grandmother routinely had conversations this way. This was surprising because the grandmother complained about the difficulty she faced writing on FP due to her old age and left-handedness (this was awkward because the shared drawing space was on the right side). Despite that, she participated because she said it was a fun way for her to communicate with her granddaughter.

Third, we saw families starting conversations by writing on FP and then migrating the conversation to IM. This was done by families in Triad 2 who primarily communicated via IM prior to using FP. They told us it was easier for them to have long conversations via IM because they could type faster than they could write on FP.

We had expected that most dyadic communications would involve families using the full screen feature, but this happened only occasionally. Across triads, the mother in the Daughter Parents family was the primary user of the full screen feature. She used it to interact with her grandson almost every night. She enjoyed watching him play and have his bedtime snack. Interestingly, when not engaged in synchronous communication, families always left FP in split screen mode because it allowed them to see both families simultaneously. That is, they were interested in seeing *both* families throughout the day.

Multifamily Communication

As stated, serendipitous opportunities for multifamily communication are rare given a variety of schedules and likelihood of everyone being available at the same moment. Thus, most *multifamily* communication that participants told us about was asynchronous, with families responding to each other's messages throughout the day (described above). Despite this, there were several routines that emerged around multifamily synchronous communication.

Synchronous multifamily communication in Triad 1 involved video from FP supplementing three-way phone calls. These typically involved the Daughter Parents family and the Daughter Grandparents family interacting with the child in the Daughter family and happened 1-2 nights a week. The daughter and mother scheduled three-way phone calls ahead of time and informed the grandmother about these by leaving a note on the shared whiteboard. They did this because they felt they needed to make an effort to include the grandmother in their interactions. However, despite the scheduled sessions, the grandmother sometimes forgot about them.

Synchronous multifamily communication in Triad 1 also included chat sessions on the shared whiteboard between the daughter, mother and grandmother. These sessions were typically impromptu. They reported that this happened 1-2 nights a week and that their chats lasted around 30 minutes. These chat sessions usually happened at night after the child in the Daughter family was asleep. According to them, they did this because it was a fun activity for them to engage in with each other, it was relaxing after a long day and they could combine this activity with other household chores such as preparing lunches and folding laundry.

“It is nice to have an adult conversation with my mother and grandmother without being distracted by [son]” – Interview with Wife from Daughter family

“It is fun and relaxing to write back and forth. Sometimes I sit down the whole time and other times I am around the kitchen making lunches [for the next day]” – Interview with Mother from Daughter Parents family

On the other hand, Triad 2 only had multifamily interactions twice during the entire evaluation. The first time was when there was an earthquake and the younger sister, older sister, and their mother wrote back and forth on FP about the tremor. The second instance was impromptu when the older sister saw both her younger sister and mother on FP. This triad did not have many multifamily interactions because their schedules were simply too varied.

Privacy

Throughout their use of FP, families did not tell us they were concerned about the always-on video or multifamily connection being an infringement on their privacy (except for the non-adopters). This was because they picked the families that they wanted to connect to and families who they had close relationships with. By choosing who to connect to, families were regulating their *autonomy* [4]. There were, however, instances of intrusion on family members' solitude and confidentiality, even for adopters.

Solitude

Although families typically used the always-on video or availability messages to determine a remote family's availability for interaction, there were instances of intrusion on a family's solitude (as defined by Boyle et al. [4]). For example, one evening, the Older Sister in Triad 2 was

cooking dinner when her 1-year-old daughter started crying. She was trying to pacify her daughter and prevent food on the stove from burning when Sister Mother started knocking incessantly on FP. Sister Mother had just arrived home from work and wanted to interact with Older Sister's family. Sister Mother was annoyed because nobody responded to her knocks when she knew they were home and wrote on FP,

“STOP ignoring me” – Note from Sister Mother to Older Sister

Older Sister continued ignoring the knocks but was annoyed at her mother. A few hours later, when the kids were in bed and she was no longer annoyed, she called her mother and explained the situation.

“If there was sound [audio] in the system I would have yelled at my mum. How does she expect me to handle so many things at once?” – Interview with Older Sister about Sister Mother

Such incidents are not easily avoidable if one family has the expectation that the other family is home at a certain time and thus available. The location of FP could help in this instance. Older Sister placed her FP in the home office, which is separated from the kitchen by the family room. If she had placed her FP in the kitchen, her mother could have seen that she was busy and might not have interrupted. Yet this would have only worked for situations in the kitchen.

Confidentiality

An always-on media space leads to privacy risks over confidentiality: remote families seeing more than one may intend [4]. However, families were able to control what the remote families were viewing by determining the location of FP and the position of the camera. For example, Younger Sister placed FP on their dining table with both the tablet and webcam facing the wall. She would occasionally move the webcam to point towards the family room when she and her son were in there. She did not report privacy concerns with FP because the location she picked, consciously or unconsciously, regulated her confidentiality. It is also interesting to note that both Younger and Older Sister, whose respective husband and boyfriend were not adopters of the system, placed FP in a non-central location in their home (i.e. dining table & home office). The remaining four families placed FP in their family room.

Families preferred hardware options to control confidentiality instead of the software option provided in FP (Figure 2). All families used the blinds less than three times during the field evaluation. Instead, when concerned about confidentiality, some families moved the webcam or placed inanimate objects in front of the webcam. This happened most often in Triad 2. For instance, when Older Sister and Sister Mother complained that they only saw the wall in Younger Sister's home, she started placing objects such as her son's new toy or a bowl of cherries so they would have something to look at. While Younger Sister may have done this intentionally for playful purposes, the unintentional effect was that she was regulating her and her

family's confidentiality by selecting objects that would be visible to the remote families.

Although there were mixed reactions about FP not containing audio, families speculated that always-on audio would be overly intrusive and would have resulted in them not leaving FP turned on all the time. They were concerned about remote families overhearing conversations about topics such as finances and health or even conversations regarding the remote families. Families wanted the option to turn audio on and off as desired. Yet even with this option, there was concern that people might forget to turn the audio off which could result in remote families overhearing private conversations.

DISCUSSION AND CONCLUSIONS

This research has revealed key routines surrounding the use of a multifamily media space. First, we found that, as expected, a multifamily media space supports the same primary routine as a dyadic family media space [14]: providing an awareness of families' lives and sharing of activities. Yet the addition of a dedicated writing area in FP resulted in families writing more about their daily life and sharing more information. This suggests that domestic awareness systems are best when coupled with video, which permits implicit sharing of life, with interaction techniques that allow explicit sharing (e.g., writing).

We also saw different patterns of usage emerge that were not found with always-on dyadic media spaces [14]. The most striking was that not all family members adopted and used the system. The successful adoption of FP in a household was greatly dependent on the relationship between members of each household. We had expected family members to form a closed circle of contacts where all wanted to stay in contact with one another. Instead, this naïve assumption proved false. Even within a closed network of families, there will be certain family members with differing awareness and communication needs. This was exposed by having more families connected as part of a media space (as compared to [14]).

We found that adopters were comfortable with and valued increased degrees of awareness beyond selective information. Initially, the adopters could be labeled as intimate socials as defined by [23]. However, while using FP, the adopters started sharing more information and even started participating in activities in each other's homes. This changed their relationship to resemble inhabitants of the same home, which is a remarkable change in families' patterns of communication, awareness, and connectedness. Even though the adopters in our families liked this, we expect that some families may find this to be overwhelming at times and unnecessary.

The previous study of the Family Window did not find that playful activities were a common occurrence for family pairs [13]. Our observation of such activities could simply be because of idiosyncrasies of the families or differences

in demographics, yet we also believe it was, at least in part, due to the introduction of a third family. Even though the majority of ludic interactions were dyadic, because there were more users, there were more opportunities for interaction and a more playful environment arose. This may be similar to differences in social dynamics when comparing a two-person conversation to a multi-person gathering, which typically has more banter and interactions.

Compared to a dyadic media space like the Family Window [13], triadic synchronous communication did not happen often in FP due to families' varied schedules and availability. Multifamily synchronous communication needed to be scheduled and was not typically impromptu. This contrasts the use of workplace media spaces which encourage impromptu and serendipitous communication. It also suggests design features are needed in a multifamily media space to better support availability awareness. This is difficult because families aren't usually in one location the way they might be at work. Providing multiple media space links throughout the home is a potential solution, yet this would increase privacy risk. Another possibility is to provide additional information such as calendars to determine likely availability as opposed to simply video feeds. Either way, more investigation is needed.

Interestingly, there was no difference in what families shared with each of the two remote families through video. Families left the video going nearly all the time and both remote families saw the same thing, despite options to obscure one family's feed and not the other's. Families also left the video in split screen mode most of the time. Families reported issues over confidentiality breach as a result of the video capturing, but this was not particular to one remote family over the other. Such breaches were not found in prior dyadic media space studies [13]. To circumvent these issues, families utilized everyday objects and changed the camera's direction rather than using our software approach of blinds. This suggests that hardware privacy controls are more suitable for the home as opposed to software fixes such as blinds, blur filters, or avatars [7,22]. Given this preference though, what we don't know is if multiple cameras were present (one per remote family), would families choose the same camera view for each remote family. We suspect this to *not* be the case given our results, but it suggests further exploration.

We have studied triadic multifamily connections as a first step in exploring multifamily media spaces. We expect that our results generalize to other triadic family connections, in particular to those situations where each family has at least one member who has a strong need and desire to connect with the other families. Cases where two of the families do not have a reason to connect, despite sharing a need to connect with the same third family, will present different situations, likely with exacerbated privacy challenges. For example, imagine an adult child's family connecting with parents *and* in-laws where the two sets of parents have no

need to connect. We also expect that moving beyond a triad to connect four or more families will present even more privacy challenges and, in these situations, the need to focus video on a subset of families will increase. This should be studied in future explorations.

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