Exploring and Promoting Family Connections at a Distance Through FamilySong

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(ABSTRACT)

This work explores the design of domestic Media Spaces by introducing and studying FamilySong (FS), a system that allows the synchronous playback of music between two remote households. FS does not share live audio or video, yet our studies show that FS provides a context for increasing serendipity as families integrate it into their ecology of communication practices and devices. Through three design iterations involving Autobiographical Design, Research-Through-Design, and qualitative research methods, we study six Latin American migrant families (with parents and children in the United States, and grandparents in Ecuador and Mexico), and one from the U.S., interact with FamilySong. We have found that, individually, family members have differing motivations and reactions to using the system. However, participants felt that the shared experience was meaningful to them and that they could use FamilySong to communicate important intentions, values and emotions as well as musical experiences. In the most recent iteration, the main interactions empowered very young children's participation in music selection. This has been met with joy and excitement by all but also with occasional behavioral dilemmas. This work explores and expands the design space of Media Spaces to include a set of artifacts that forgo its central definition yet provide similar emergent qualities including enhanced mutual awareness, connection, and communication. FS design explores the intersection of family practices and values—of togetherness and longing, parent-child dynamics at all ages, kinship, identity and culture—, and divided versus focused attention in the home. It also enriches our understanding of designing technology for meaningful interaction that supports loved ones and their values.

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(GENERAL AUDIENCE ABSTRACT)

Telecommunication technologies have improved the lives of migrants by allowing them to maintain connections with far-away loved ones. Although the opportunities to have a conversation have increased drastically with inexpensive video-chat systems, the quality of these connections leave families wanting for more meaningful experiences. FamilySong was designed to help far-away loved ones sustain significant interactions over time by playing music at the same time between two connected homes. The music acts as a medium for a shared-experience between parent and children's homes, and their grandparents' home.

As participants went about their daily lives, music would begin playing making them feel together. Music also allows for a range of interactions that our participant families have come to describe as communication. People choose to play songs in the system that could be interpreted as "I love you," "I am thinking of you," "good morning," "this is my/your favorite song," "we are home," "are you available to talk," "we are dancing," "happy birthday!" These *messages* have the potential for being more influential to a developing relationship than merely asking for a "hi" or a "smile" on a video-call. Such calls are typical when interacting with very young, pre-verbal children. Other researchers have promoted focused activities that would capture a young child's attention, in order to provide a moment of connection at a distance with them. Some of these approaches include playing games and reading books.

Our proposed method of sharing music is aimed at a similar objective, developing participants shared interests, but also facilitating an opportunity for a long sustained experience

through the day with music as the background for everyday home activities. FamilySong is a design for the home and for the family, we build upon the family's communication and cultural practices in order to augment their experience through the day, and the video-calls they typically hold where they might now have found new reasons to connect (talk about music or sing together). In this dissertation we have used design to extend our understanding of what constitutes a significant interaction between family.

Three large steps were taken, culminating in the design and creation of a high-fidelity prototype for a system to facilitate synchronous-playback of music between homes. A total of twelve copies of the final prototype were created and deployed at the homes of participants, for a total of six families using the system for over six months at the time of publishing. An additional three devices were created to begin exploring future work opportunities. In exploring these interactions between people we have found that family members have differing motivations and approaches to enjoying the system communicating. However, the opportunities for increased connection was received with joy by most of our participants who expressed to us deep feelings of longing for togetherness, identity, and culture. These significant aspects of enduring human and family values provide meaningful motivations for designing for the home.

Dedication

To my wife Vanessa: I could not have done this without your support and encouragement.

Endeavoring into this journey together was our second greatest decision and source of pride.

I am so happy we get to sing together.

To my daughter Emma: Baby, in so many ways this story is only possible because you are a

huge part of it.

To my parents Javier and Linda: I believe that this work expresses your particular

sensibilities and values, as I have loved them always and try to live by them.

Acknowledgments

In the spirit of this dissertation, I want to describe this body of work as a love song with many very special voices contributing to its performance and composition.

I would like to specially acknowledge my advisors Deborah Tatar and Steve Harrison. You have been a source of inspiration and have shaped the way I think about the world and its problems big and small. The environment for growth that you provided me and your other students demonstrated the great care and compassion that we should strive for in our pursuits.

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I am indebted to the many backup singers, without their support none of this would have been possible:

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Chapter 1

Introduction

FamilySong aims to connect loved ones at a distance by establishing a shared synchronous music listening experience. In this project, we began by focusing on connecting families of Latin American graduate students living in the east coast of the United States with children 2-7 years old, and the children's grandparents in Central and South America. Figure 1.2 depicts this separation. These families enjoy many opportunities for communication and benefit from their schedules being similar due to being in roughly the same timezone even though they live tens of thousands of kilometers apart. However, many issues arise in developing a network of practices, devices and services to maintain connection with dear family members [68, 69, 105] complicated by issues with sustaining rich interactions at a distance [8, 58, 74, 78, 79]. With very young children (sometimes pre-verbal) the opportunities for direct inter-generational bonding are very limited. The HCI and CSCW communities have extensively explored the difficulties of sustaining rich communication and developing meaningful relationships between small children and far-away relatives [3, 5, 70], including through the use of domestic media spaces [58, 59, 104]. Our design impetus begins with a whole family approach. Parents have an overarching interest in family connections while keeping control of their time, privacy and intimacy. Evjemo et al. [27] recommend that systems connecting young children and grandparents should offer a *context* for participants to take up in their interactions.

The approach we have taking to connecting families through synchronous music is the result
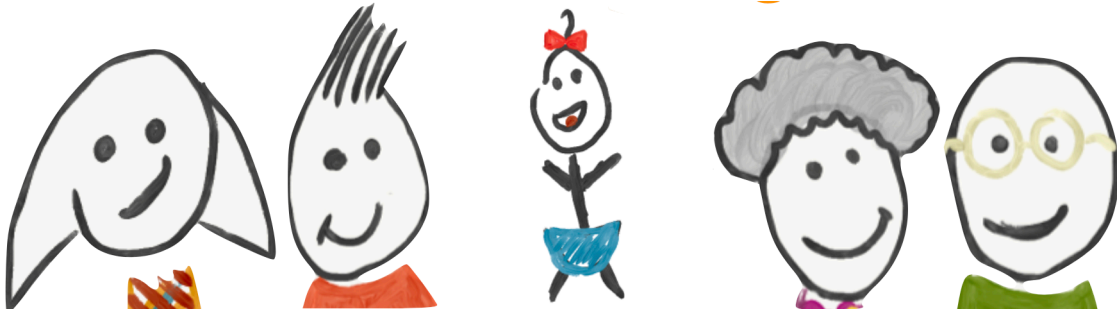
Figure 1.1: FamilySong is a technology for the home, designed to be enjoyed by all members of the family and to help them connect at a distance.

of extending earlier work in this design space by colleagues and other researchers [], using autobiographical design [76, 77, 79] and research-through-design (RtD) [40, 106, 107].

1.1   Research Questions

FamilySong is an evolving design proposition in a space centered around the technical establshment of a system that enables real-time connection between remote households via shared synchronized music. The most important emergent feature of this type of connection is its ability to support kinds of motivations, enjoyments and behaviors from and between children, parents and grandparents separated by migration, even when their needs and preferences are asymmetrical. Our research questions ask:

RQ1 What does FamilySong, in combination with an ecology of systems of connectivity, tell us about sustaining significant connections without becoming overly intrusive?

RQ2 What does FamilySong tell us about fostering the sharing of music, the knowledge of music, and subsequent interaction around music between family members?

RQ3 What does FamilySong tell us about balancing expressions of control and agency,

musical taste, and communication by all family members in this design space?

In this dissertation we will describe our efforts to study the phenomena surrounding the use and emergent design of FamilySong and how we conducted research to address these four research questions, while also offering a theory regarding the design space and recommendations for designing for families.

1.2 Preliminary Motivations

After moving to the United States with my wife Vanessa and our then 1 year old daughter Emma, we began experiencing the complexities of facilitating communication between Emma and our far-away relatives. Our home experiences echoed what researchers have described about video-call communications with very young children []. Emma did not reciprocate her grandparents' communication intentions, lost interest quickly, and did not respond to speech prompts in the ways her grandparents hoped. Although her social abilities continued to developed as she grew, her dominant language was not Spanish causing a furthering of the divide we were feeling. We developed several emergent strategies for supporting entertaining interactions to make video-calls more engaging to Emma and fulfilling for her grandparents.

Two parallel approaches were progressively developed by each set of grandparents. My parents played a object-naming game with Emma where they would show her toys and objects around the house and she was expected to shout back their names in both Spanish and English. Vanessa's parents reacted with we interpreted as joy to hearing Emma sing nursery rhymes in English, realizing that though the lyrics were different the melodies remained. We took to teaching Emma the lyrics in both languages which she seemed to enjoy. When the opportunities arose, Emma and her grandparents would attempt to sing together as well.

Figure 1.2: The families in this study struggle finding ways to maintain relationships with far-away loved ones. Using our system they can connect by sharing music.

Latency in the communication detracted from the experience but they seemed to enjoy it.

The object-naming game seemed successful on its own. In theory, we could have played it locally at home, but we did not because the connections to grandparents and the actual toys and objects seemed like integral parts of the game itself. See Figure 1.3 for an idea of the types of objects and organization structuring that my parents used. Our first visit back to Ecuador after being in the United States for over a year meant reunion with both grandparents and their objects. In fact, my parents re-introduced themselves to Emma by showing her their house and the objects that she had learned to name. Subsequently, they introduced decorations for which she displayed a preference on her visit into the remote game. At times, not surprisingly since this was the initial motivation for the game, Emma seemed to be attracted by a video-call so that she could play the game, perhaps being more interested by it than *talking* with them. My parents continued growing their collection of toys and objects until Emma was much older. She eventually lost interest in the repetition around 5 years of age, while at the same time becoming more able to sustain complex conversations.

In this process we collaboratively developed a working language that reflected Emma's evolv-

Figure 1.3: Objects around my parents house that we used as part of the object-naming game they developed with Emma. They eventually collected a basket of toys and kept it close-at-hand in their living room.

ing capabilities and allowed us to be engaged in an interaction together. Initially, my parents would show something on the camera, point to it, and say, for example, "dog." Later, Emma would say, "dog" and then, "show me the dog." At the same time, we would engage in code-switching between English and Spanish, so one person would say "dog" and another "perro." This affected not just Emma but also my parents who slowly grew comfortable speaking English, unencumbered by self-consciousness.

Singing together was always complicated, or impossible, because of the perceivable latency of the communication. Attempts at singing together resulted in a perception of mutual interruption that was not enjoyable. The adults would stop singing because of the lack of synchronicity, but, more remarkably, Emma would stop singing as soon as my mother-in-law's voice would sound in way that was out-of-sync. Eventually the opportunities for this kind of direct interaction, through my mother-in-law teaching Emma Spanish-lyrics to the new nursery rhymes, was also exhausted as no more favorite songs were found. These efforts provided the inspiration for one initial motivation in designing FamilySong: Teaching Emma and her grandmother new songs to enjoy together. We saw this as parallel to the creation

of common ground that occurred through the object-naming game.

These interactions echo the kinds of findings that have encouraged researchers to supplement focused activities by making visually attractive shared prompts like Family Story Play [4, 82], StoryVisit [83], People in Books [32, 33], TakeMeWithYou [70] and ALLT-Book [70]. Both of the strategies that we observed by the grandparents emphasize the significance of simple and intimate connections to building relationships through the shared creation of meaning and identity at a distance. My mother-in-law, in particular, saw the effort to get Emma to sing songs in Spanish as an attempt to help Emma maintain her identity as Ecuadorian.

Although the grandparents' role in these activities is foregrounded in much of our description and discussion, it is important to note that the parents' contributions are subtle but very important. Parents create the conditions under which these interactions could happen; they enjoy and participate as spectators; sometimes they sing along, display their own knowledge of the songs; monitor and redirect the child's attention and also occupy the connections time with their own conversations to their parents and in-laws. The burden of connectivity did not fall upon the child but was constituted in the shared space created through the video-call.

An additional fountain of inspiration came from Michael Stewart's PhD dissertation work in CoListen, an iOS application to let networks of friends, especially 10-14 year old friends, listen to synchronized-music []. In what became some of the initial steps of prototyping FamilySong we considered using Stewart's CoListen iOS app to enable the connection but quickly strayed from his implementation as it seemed unable to address concerns regarding music-listening as a home collective experience, as opposed to individual headphones-based music-listening. Particularly, using a parent's and a grandparent's smart-phone to establish the connection would mean that usage of FamilySong would exist in more direct competition not just with the family's attention but also with that user's phone needs. A dedicated device was thus deemed necessary and a Raspberry Pi based solution was used to leverage several

Open Source projects and leave the room open for future growth.

The design of FamilySong was also inspired by the work on Media Spaces, designing for couples, and mediated family life, carried by members of Virginia Tech's ThirdLab. Based on a trend of Media Space research focused on addressing privacy concerns by limiting the live audio or video feeds [], we took a sideways approach by leveraging shared music to facilitate the connection. Thus, our design proposal merges 1) an opportunity for mutual awareness through ambient music with 2) established family practices of daily communication via video-calls and instant messages. Conceptually we also focus on Harrison et al.'s the distinction of *Space* and *Place*, where "space is the opportunity; place is the understood reality" [50]. Music through FamilySong works towards the creation of the opportunity that these families collaboratively create, expanding their living rooms to include the remote loved one's living room and so share in each other's daily and mundane activities.

1.3   Contributions

The initial Autobiographical Design approach provided inspiration and feedback around the design intentions tested on our first study []. In addressing RQ1 and RQ2 through that first study, we contributed to the general understanding of what can constitute a significant connection between family members by showing that the music-only connection was deemed meaningful by our participants.

In order to gain a richer understanding of the phenomena and to deepen our contribution, we developed several prototypes of stand-alone music listening devices that could be easily distributed to more families. These efforts culminated on the creation and deployment of fifteen bespoke wooden boxes (with built-in speakers, a touchscreen, and an RFID card reader) and their subsequent study in the houses of six families in the United States, Ecuador,

and Mexico. The RFID card reader was introduced as a design response to our participants' observations that their young children were unable to make music selections through our system, and that their constant requests for music was taxing on their time. In addressing RQ3 with the RFID-based CardSong interface, we explore the dynamics of the families as they work together to understand and develop their relationships at a distance.

The results of this dissertation are:

- The design and implementation of FamilySong to provide the synchronized-playback of music in distant homes.

- Use of Autobiographical Design and Research-through-Design methods, along with qualitative analysis of interviews to study how families communicate and adapt FamilySong to their practices.

- The design and implementation of the CardSongs interface to provide an accessible way for young children (and adults) to make song selections at home.

- The setup and study of multiple long-term deployments of our system spanning three countries.

This is not an exhaustive list of the contributions from our work but a highlight of our most relevant achievements to date.

1.4 Overview of Thesis

This dissertation begins with an introduction in this Chapter 1 intended to explain the motivations, both conceptual and personal, to pursue a better understanding of how families

with young children interact with loved ones at a distance. In this same chapter we define four research questions that are answered through our investigations using design methods.

Chapter **??** provides an overview of relevant literature for several research areas that influenced our work and that we have contributed to.

The first small-scale study with two families over a period of two weeks is described in Chapter 4, including specific takeaways that strongly motivated the changes made to the system used in our second study, which is described in Chapter 5.

Lastly, in Chapter **??** we conclude this dissertation with a discussion of the theoretical implications of this work. Furthering the understanding of Media Spaces by suggesting an expanded design space that includes other projects, not typically defined as Media Spaces, but that we believe share in their motivations and emergent properties of mutual awareness and serendipitous interactions.

Chapter 2

Related Work

FamilySong builds upon decades of human-computer research on Media Spaces at work [7, 23, 25, 42] and in the home [58, 59, 60, 101, 103], research to promote and protect privacy, and investigations of simple, intimate connection. Researchers have tried to determine an appropriate balance between serendipitous habituated connections and communication and concerns for privacy and intimacy [8, 26, 31, 74, 78]. We are not alone in conceiving of music as an important nexus for this, and so we build on existing research in musical connectivity; however, the particulars of the kinds of families we are trying to connect, the capabilities of young children, and the network of concerns, connections and life circumstances between the parents and grandparents lead us on a novel design journey.

Humans have a basic need to maintain connections, especially with loved ones [53]. The current work begins to drill down on a design potential associated with internationally-separated families. The design solution we propose and explore here constitutes a weaving of design opportunities and tensions into realized action [94] that is of direct interest and as part of a historical, cultural development. FamilySong offers a remedy to the fact that interaction on video-chat is most successful when participants are engaged and focused. This remedy is important for all family members but most important because young children have difficulty engaging in focused interaction in the absence of a shared sensory environment [3, 5, 68]. Particulars of the design go beyond remedying a problem to the creation of the opportunity for multiple valuable kinds of connection and intimacy for all users.

2.1 Family Separation

Family separation across international borders creates conditions that arguably make the maintenance of connection even more important than it would be otherwise. But not all separations are the same. In this case, participants have geographic distance and live in different cultural contexts than one another; however, unlike in other work that addresses forced migration, they are not fleeing injustice and their living situations are stable. Mobile connections have been explored [65] and may be design requirements under more fraught conditions. So, though sharing many of the same concerns and values, the current exploration is of a different part of the design space that allows us to draw on the power of the creation of shared place.

2.2 Extending Space

Media Space was the early idea that video and audio connectivity could be envisioned as an extension of physical space. The core idea of extension turns out to be more complex— both more and less than the original Media Space impulse—so it still requires theoretical explanation, design elucidation and empirical, experiential exploration.

The earliest Media Space research used "always on" audio and video connectivity [7, 23, 25]. It focused on facilitating serendipitous, as opposed to planned, opportunities for interaction and collaboration. In this original conception, "space" was the opportunity and "place" was the socially understood reality [50]. "Place" was therefore a social construct that appeared in the intersection of a specific location, of people interacting in it, and of events occurring [51]. A Media Space sets up the conditions under which places for shared experiences between participants may be created. The potential for serendipity is an important and enduring

value in the design of such systems.

2.3   Privacy

One area of foundational complexity is that using technology to extend space has different effects on visual and audio perception, so that from the earliest days of research it became apparent that advantages to one did not always align with advantages to the other. People can more easily gauge their behaviors and the behaviors of others in the visual realm than in the audio. This underlying difference led to a great deal of exploration of privacy [49].

Prior work has sought to address privacy concerns through various mechanisms. The first observations of the seminal Media Space at Xerox PARC showed that users would make actions private by simply occluding or refocusing the camera. The RAVE Media Space at EuroPARC expressed a concept of degrees of engagement in a highly configurable Audio/Video Environment. Users could select between different modes of connection to remote locations, from brief one-way connections called sweeps and glances, to two-way office-sharing and video calls. Users could also determine which individuals would be able to initiate any of these types of interactions [41]. Other authors have attempted alternatives for assuring privacy by filtering the audio and/or video to remove sensitive information, by encrypting communication channels to prevent eavesdropping, and using sensors to provide feedback on connectivity and presence [8, 26, 31, 74, 78].

In each case, the creation of privacy reduced the potential for serendipitous encounters, creating a kind of gradient of trade-offs.

2.4 Intimacy

Privacy is not the only challenge to the successful use of media space connectivity in intimate settings. An omnipresent human challenge is how to negotiate the unfolding of interaction over time. There are multiple and overlapping frames of experience from from public to very intimate. When is it appropriate to say something? How long should a contribution to conversation be? What is enough to say? [15, 16, 17, 85]. Task-oriented, goal-directed speech is easiest to gauge and regulate, so much early research engaged in examining how well it could be conducted, for example, with and without video [28, 29, 30, 37, 62]. Indeed, video-based interaction with children suffers from lack of context so that Ballagas et. al., [5, p. 162] write "most families still had trouble keeping the children engaged for more than a few minutes ... videochat alone seems not to be sufficient for addressing families' desires for a sense of togetherness." Some research on promoting intimacy has prioritized serendipity in creating context.

The current work is in the realm of Domestic Media Spaces, those that can facilitate the building of relations between remote family members. Judge et al. [58] contrast *sharing conversation*, fully-engaged experiences that focus on an exchange of messages through the medium, with *sharing life*, that is, sharing daily activities especially with respect to toddlers and infants (e.g., feeding and bathing babies, or watching them sleep). Sharing life contributed to a sense of connection between remote family members. A more focused approach to sharing life is exemplified in Performance Apron and Talking Bottle [11], a project that brings design attention to a particular kind of moment, the experience of shared cooking, by using everyday items augmented to permit the exchange of messages and sounds in the kitchen.

Arguably, the trade-off between privacy and serendipity became even more important in

Domestic Media Spaces than in workplace ones. A negative outcome is that some participants who do not wish for connection may avoid the room where a domestic Media Space is installed. Some such media spaces have promoted privacy by avoiding the use of microphones altogether, or implementing virtual restrictions on the two-way video such as lowered-frame rate or resolution, or occlusion via virtual blinds [59].

2.4.1 Expressive, Intimate and Minimal Communications

A number of important lines of research solve the problem of privacy and serendipity by creating minimal, punctuated moments of anticipated attention. They emphasize reminders of the idea of the remote person rather than in-the-moment, known, verifiable interactions.

By relaxing the constraint of making a shared *space*, Strong and Gaver were able to experiment on "designing for minimal, expressive communication." Feather, Scent, and Shaker allow their user to engage the remote partner's sight, sense of smell, and touch, respectively with a remotely-activated gesture [91] that caused a fan to make the feather to float in the air inside an enclosure, essential oils to burn to impart a pleasant scent to the room, or an object to vibrate (shake). These actions contextualize a potentially powerful communicative intention between intimate partners, transmitted and received with minimal cognitive effort.

Brereton et al. [9, 10] showcase more opportunities for minimal, unobtrusive connection with their Messaging Kettle and Ambient Birdhouses. Both projects create artifacts that combine message and opportunity. By glowing in one place when in use elsewhere, the Messaging Kettle can be seen as providing ambient knowledge and associated sentiment. The object sits in the background and does not require attention, but does permit it.

We consider these projects at one extreme of a design space also occupied by Media Spaces because of their openness to casual, serendipitous awareness.

2.5   Beyond Intimacy: Music as a Nexus

Sound and music are more important than many tend to realize. Horowitz [56, p. 12] argues that the vibrations associated with sound are the foundation of the first sensors created by organisms, the most primitive form of detecting change in the environment (through motion in aqueous surroundings). Hearing is a specialized form of detecting vibration. It thus constitutes an elemental form of embodied connection to the world, including, of course, other people. The mother's breath and heartbeat are early sensations, both heard and felt. Dance, a human activity that crosses ages, cultures, and history, ties together the experience of particular forms of sound that we call music with physical expression, often in a social context.

These encompassing properties have been described in the literature. Music is described as an agent in developing "social, psychological, and emotional structures" [64] and as a space where relationships are built. O'Hara et al. [81] argue that all the activities surrounding music, from listening or overhearing it, to selecting and purchasing it, form our cultural identity and give shape to our experiences of sociality when listening together, or sharing music with others.

Music may act as a recognizable sign [19, 20, 21] but technologically motivated changes to how we encounter music (such as via ring-tones and notifications) may push the meaning of music-like sounds more towards limited foreground content (such as *"answer the phone"*) rather than rich cognitive or emotional experiences [47].

2.6   Co-listening

Prior work has brought together music, intimacy and Media-Space-like connectivity. Building on the allusive properties of music, Kirk et al. focus on sharing. They emphasize the role that music can have in bringing people together who are *spatially* co-located [61]. Their PocketSong system enables such connections between strangers.

Kirk et al. also support and mention *temporal* co-listening but it is not their focus. The CoListen project [89, 90], discussed below, uses the term *co-listening* to designate *only* temporally synchronous listening. We follow CoListen's usage because we explore the emotional immediacy and assurance of known temporal synchronicity.

MissU is close to the current vision because it investigates the importance of "sharing empty moments" in the daily routine of romantic couples living at a distance, as a way to enrich their lives [66]. The project integrated the consumption of music into a media-space-like environment. The couples shared a private-radio station with a user-controlled option to transmit ambient sounds through a microphone. Users were able to listen to music synchronously and also mix-in live ambient audio from their microphones. Participants employed a range of different behaviors with MissU. Some used it as an always-on connection, some as a readily-available phone, and some as a shared music player only. This allowed users to have different relationships to the music itself, running from focused attention to ambient background.

Like MissU, the CoListen project supports a range of relationships to music; however, MissU integrates different modalities, creating one trade-off between privacy and serendipity, while CoListen [89, 90] takes a different approach. In CoListen, only music is shared, thus eliminating any concern about inappropriate over-hearing or distraction. CoListen is aimed at students, especially 10-13 year old children, who wish to maintain a sense of contact with friends—even though explicit contact may be unavailable or forbidden for various reasons

including maintaining a primary focus on homework. It assumes one child in a location per device and is therefore aimed at children listening with headphones. Unlike MissU, it also assumes that students exist in fluid social networks that may involve switching partners in the shared listening endeavor.

In conceiving, designing and analyzing the current work, we have found ourselves tying together these threads of the literature. Initially, we considered the ways that Media Spaces try to allow participants to feel together; however, technologies that provided sharing in the office were seen as intrusive at home. We found inspiration in simple but highly expressive designs for sharing, such as those in [9, 10, 91], but these focused on a kind of notification, punctuating ongoing moments with thoughts of the other, rather than providing a shared background. Along with our personal observations, other lines of research led us to consider the immediate, on-going and enduring properties of music for shared experience, communication and building relationships [61, 63, 64, 81].

Work in this area balances privacy and serendipity on one hand and intimacy and intrusiveness on the other. The balances that projects choose are tuned to the kinds of relationships and situations that they address. Like MissU and CoListen we saw that music could ground relationships [66, 89, 90, 97]. At its best, synchronous shared music can support important human values.

Chapter 3

Methods

In this dissertation we explored the phenomena surrounding family connections at distance involving small children. Based on some initial observations and motivations described in Chapter 1 we engaged with groups of users to probe a design space situated in the homes of Latin American immigrant families with very young children. Our focus was on providing affordances for connection through non-intrusive interactions. In order to do this we guided our efforts with a Research-through-Design methodology [106, 107], iterating and refining on a series of artifacts based on rich interpretations of usage and experience gathered from our study participants.

In the broad scope of Human-Computer-Interaction (HCI) and Human-Centered Design (HCD) practices, our work is centered on a phenomenological approach, situated around the particular families context of use and constitutes an example of third paradigm HCI [24, 48, 92].

Research-through-Design (RtD) as a methodology guides our research process through design-based practices and methods [34]. Specifically, in this work we are influenced into understanding our conjectures as *Wicked Problems* [84], in that the formulation of the problem and the solution for it has to happen simultaneously. As opposed to other scientific endeavors and searches for knowledge, a wicked problem cannot be modeled by reductionist methods as the system itself is not understood. Furthermore, attempts at understanding wicked problems have to go hand in hand with the interventions that alter the problem itself, by for

example suggesting there is a problem. Time also changes the characteristics of the problem as its many actors move, grow, become more involved or cease to be interested on the issue. In our work, we see that the multiple perspectives, motivations, and values of children, parents, and grandparents do not necessarily align (but may find synergies), and neither do their initial descriptions the problems. As designers it is our goal to move the state of affairs into a more desirable position by balancing tensions that arise at multiple levels [94]. As researchers we are interested in understanding what knowledge we have gained in this process [106, 107]. RtD methodology proposes an iterative process where we (1) observe, (2) introduce design artifacts in the space, probing to observe changes, and then (3) through a method of analysis, reformulate our understanding of the state, uncovering new knowledge. This is a cyclical process and may utilize various design methods in its various steps.

We began exploring the problem of connecting families by using Autobiographical Design (AD) [76]. An AD approach is justified when the goals are to address the "true needs of the researchers" [76, p. 514]. Not coincidentally, AD has been used in prior scholarship around domestic Media Space and technologies for the home [9, 13, 22, 43, 54, 55, 59, 73]. Navigating the intricacies of family relationships, concerns for privacy, varying needs and values of family members requires careful treatment and analysis. AD can serve as a preliminary method of exploration that we can use to illuminate the phenomena close at hand, as would-be solutions are quickly tested, iterated over, discussed with stakeholders (in this case, the researcher's family members) in a continuous manner. AD also supports the researcher to reflect on their own experience as potential user. However, AD is limited in that some aspects of the solution could become more intricately tangled with the participants. AD illuminates a single group's perspective (in this case, the researcher and his family's).

The initial AD approach helped us take a first step in designing, prototyping, debugging and rapidly improving our FamilySong artifacts: Standalone boxes that, when located in

the families' homes, created a music-based shared environment and stimulated interactions through and around said music (Chapter 4). By engaging in AD, we uncovered the possibility of synchronous music as a medium to support simple intimate connections between remotely-located family members, as exemplified by my then two-year-old daughter's interaction with her remotely located grandparents (Chapter 4). At the same time, we were concerned with the tensions that may arise upon the introduction of FamilySong at the expense of privacy in the home.

Building on our AD experience, in the span of four years, we embarked on a Research-through-Design [106, 107] to understand our users' values around remote, synchronous music sharing for families with young children separated by distance. We used variations of the FamilySong system and introduced it to other families to use in their homes. Our design intentions were expressed in the form of two technology probes [38, 57], letting us observe the system through ecologically-valid and genuine use in the home extracted by user interviews. These efforts are described in Chapters 4 and 5.

Through these technology probes and the corresponding research which involved participant observations and interviews, we have focused on addressing the contrasting perspectives of participants by framing them as design tensions [94], informing our progress in addressing these tensions through the lens of value-sensitive design [35, 36]. As such, we have tried to explicate the individual and family values expressed by the participants with thick descriptions [45] that highlight the context, use practices, and values around the system and music sharing in general. To uncover the phenomena of interest in our observations, we have relied on grounded theory and qualitative analysis [12].

Our focus on cases of actual use provides thick descriptions of experience that we believe cannot be easily replicated in laboratory studies. Furthermore, the situated nature of technology use, particularly of FamilySong and the values around music sharing with family

members at distance requires a research approach that highlights those aspects. We believe approaches following other epistemological traditions — such as those that are categorized in the first and second paradigms of HCI [48, 52] — do not provide us with the richness of situated information necessary to illuminate possible reformulations of the problem.

Through this work, we hope to add to the rich scholarship around RtD and its value in navigating through wicked problems. In particular, we feel that our adaptation of RtD to understand intimate family connections and ways in which technology could facilitate simple, unobtrusive connections adds to the call for careful consideration of technology design in such intimate settings.

Chapter 4

Design Explorations to Understand Family Connections

As described in Chapters 1 and 2, we developed the idea of sharing music at a distance by combining behavioral and design influences with a consideration of enduring issues and themes in mediated connectivity. The song-based interactions between Emma and her grandparents with us as intermediaries provided one kind of model. Support for middle-school children collaborating via Colisten provided another.

This chapter reports on the evolving design of FamilySong as a socio-technical system influenced by Autobiographical Design (AD) [76] and eventually engaging more families through Research-through-Design (RtD) methods [40, 106, 107]. Both AD and RtD are components of handling wicked design problems in which the definition of the problem and solution are tightly coupled [84]. AD is appropriate when the researcher has personal and intimate access to the complexities and priorities of the design space and enduring interest in the outcomes. RtD engages participants in the elucidation of multi-faceted, tentative and unknown aspects of the relationship between technological decisions and use. In this case, the researcher's own experiences and informal encounters constitute one basis for adjustments to design and approach. RtD began an engagement with other families and their priorities, values and practices.

We began experimenting with this general idea for music-based connectivity between our

home and that of my mother-in-law, since we perceived she had already created connection through music. Testing the initial implementation by connecting with my in-laws led us to some significant reconfiguration of the available interface and music catalog, leading to studying the redesigned system with two additional Ecuadorian families living in Washington, D.C. and Atlanta, GA, who were interested in exploring our approach to connecting with their children's grandparents in Ecuador.

We conclude this chapter with design insights learned from these two iterations, and how they motivated our continued explorations into connecting families at a distance.

4.1 Initial Explorations on What to Share: Autobiographical Design

The autobiographical portion of this design journey began by observing the interactions between our primary researcher's young daughter Emma (initially 18 months) and her grandparents: Javier and Linda (my parents), and Manuel and Loly (my in-laws); all over 50 years old. As described in Section 1.2, both couples developed strategies for keeping Emma entertained: A bilingual object-naming game using toys and decorations, and singing together along with teaching lyrics of new songs in Spanish. In our first design attempt, we focused on Loly's and Emma's musical interactions intending to connect them in the context of building a larger song *vocabulary*. We concluded that FamilySong could provide more opportunities for both to keep learning new songs together in English and Spanish and that this provision of care for Emma would be valuable to us and our parents.

The lessons that we took from these initial observations and related work helped us identify a novel place in the design space that balanced different design tensions [94]. We wanted

to support the family as a whole, but individuals within the family have different concerns and needs. Success would consist of both (1) *satisficing* across the realities of people's lives, children's capabilities and interests at different ages, and the current infrastructure for technology within and across distances and (2) enhancing feelings of connection and behaviors that increased connection.

An initial concern for this design space was to emphasize the connection without detracting from day-to-day activities in the home, and to assure that all members of both families would continue to feel comfortable in their own living rooms. Like CoListen [90], it would position itself along the privacy-serendipity trade-off to avoid intimacy violations. But it would occupy a different place; because it aimed to connect entire families, music would be played publicly on speakers within each household. The connection between adults, and adults and children within each household was significant. But family members are often busy. FamilySong would implement a medium, that like Feather, Scent and Shaker [91] would require very little attention from the users, while offering a shared space that *could* come into focus for individuals or family members within and across households as they pleased.

Since our first implementations, FamilySong was envisioned as a system that would allow participants to select and listen to music together at a distance in their living rooms. Furthermore, we were concerned with providing users with assurances that the connection was occurring. From here on out, most of our design considerations surrounded these provisions for assured synchronicity and giving agency to participants in choosing the music they wanted. Some of these aspects and perceptions were met within the system's own affordances, while others were designed to be met within other well-established communication practices each family had developed.

4.1.1 Designing for Awareness

An initial concern was whether and when people at remote locations were actually paying attention or not. This created an early design conundrum for us because the focus on not distracting from day-to-day activities can be seen as being in direct opposition to designing so that the system could communicate the availability of the other family members for interaction. Our initial design proposition was similar to that in early versions of instant messaging platforms, which would issue alerts if a person in our contact list became online or went offline. We believed that this approach to proactively notify people in the home of their existing connection was necessary for the enjoyment of the experience.

While prototyping this, we conceived of using presence sensors to automatically dictate availability. The more realizable alternatives included using a Bluetooth scanner so that our system could tell when a users cellphone was in the same room as our device. More complex alternatives, such as using a computer vision based system, were undesirable as they would step into participants' privacy concerns that we were trying to avoid. Ultimately, we implemented a simple touchscreen based solution with the users' faces as toggleable icons, allowing them to self-select their availability by tapping on their faces.

We proceeded with implementing and testing several notification systems, along with some specific constraints expecting that the system would develop certain affordances. The most important of these was to make music play *only* when participants on both homes indicated they were available. If only one home was occupied, music would not play. Our intention was that music through our system to be immediately and inexorably interpreted as existing because of the connection. This feature was immediately rejected by the family. With this restriction FamilySong did not work as our primary music listening device as it required the remote interaction. Since we were not home most of the day, my mother-in-law did not get

to use the system and used her radio instead. Meanwhile, we could not use the system as she never remembered to make herself available. At this time, we decided that an automatic presence detection system would not address the issues some of us were having and elected to forego the possibility of music directly standing-in for the presence indicator.

Other simple notifications were tested including both subtle and more disruptive bell sounds, or actually shouting messages like "Javier is listening to music now." They were either not perceivable, too distracting, or outright disturbing in some cases. We proceeded by not including any of these alternatives, and let participants use their existing communication methods (e.g., text messages, video-calls) to ascertain availability.

4.1.2   Concerns about Music Preferences

The initial music selection was constrained to the albums and songs we were able to upload to our music server. We made available a collection of children's music, from CDs that were gifted to us by friends and family. We also added a few albums that we owned. To say the least, our collection was very small but chosen to push our goal of sharing music between Emma and her grandparents.

One important point that my wife and I believed ought to be addressed in our design was her mother's frequent and scheduled listening of a local christian radio station, which we did not find to be enjoyable. Supporting this frequent activity was not something we could achieve with the software and hardware architecture we had chosen, therefore she continued using her radio player for it. However, this raised concerns about how best to make available each user's preferences and also facilitate ways in which others could affect their local experience without sending the wrong signals to the remote party. Particularly, we believed that stronger notifications would force participants into behaviors that they did not agree to for fear of

appearing critical of other's music selection—picture leaving the room just after someone else made a music selection, only for the system to shout "Javier is no longer listening with you!"—.

To begin addressing the perceived issues we added access to Spotify's broad catalog of music, after confirming that it contained a wide selection of music in Spanish—including Catholic music but no live sermons—. Regarding the fears for unwanted signals as mentioned in the previous section, we backtracked on our initial ideas for a notification system and restricting music when one party was not available. Imposing less technical constraints through the system also aligned better with our preference for socially-mediated solutions and actually observing how families would appropriate FamilySong.

Iterative design and debugging continued as we began to study use and reactions to the system in two new groups of families, recruited through personal connections. Both family groups consisted of parents and young children living on the East Coast of the U.S. and remote grandparents living in Ecuador. This geographical constraint meant that our participants did not have to negotiate significant time-zone differences when communicating.

4.1.3   Findings

FS met with initial success in that Emma and Loly found that, although they could not sing together (because of latency) they could still share songs in other ways in interactions held *after* listening to them through FS. Emma would sing nursery rhymes in English, which Loly recognized. In turn, Loly found that though the lyrics were different, melodies persisted. She enthusiastically tried to teach Emma the Spanish-language versions of those songs and Emma began to sing in Spanish as well.

The importance of the ability to have *subsequent discussions* of the music was an important

outcome of this experience.

Initially we believed that making people aware of the remote participants' status was paramount to the experience. However, neither notification system proved entirely satisfactory due to their obtrusiveness. There were immediate complaints that *audible notifications* interrupted the enjoyment of the music, and forced the system to the forefront of attention. Similarly, *bilateral availability* imposed too high a barrier to listening to music, requiring coordination that took away from spontaneity. Loly listened to her favorite radio station playing while doing chores but Emma and her parents were away all day. Bilateral availability meant that Loly had to use a different music system most of the time, only switching to FS when prompted.

Initially music selection was limited by an available collection of .mp3 files and CD's. Though some music was in Spanish, all the available children songs were in English. Although Manuel and Loly learned what music was accessible to their grandchild, it did not include the repertoire that Loly preferred in her home.

4.2 FamilySong: Building the Initial Prototypes and Software

While we moved towards defining what FamilySong ought to be, we quickly moved away from Colisten's mobile app approach due to concerns with the devices used not being solely dedicated to the music. Other alternatives considered included the breath of smart-speaker systems that were already available in the market (around 2015) some of which offered to synchronize the music through the local network (e.g., Sonos smart-speaker solutions). This type of smart-speakers would have required a Virtual Private Network (VPN) setup between

the two connected houses. Utlimately, this idea was also discarded due the perceived high-cost of these high-end speakers and how rigid the interactions with them would be —the devices themselves are not programmable—.

Leveraging my experience with deploying systems on Linux, we opted for using open source internet radio station software. Thus, we were able to implement a flexible architecture that would allow various devices following open protocols to access our private radio station. The first implementation consisted of a Virtual Machine hosted at Virginia Tech's Computer Science Department serving an mp3 HTTP stream through the Music Player Daemon (MPD) and Icecast2 —both widely-used software projects—. We tested this basic system using the VideoLan Client (VLC) multimedia playback program on two computers, and an MPD client software that let us choose songs from an mp3 collection, through a Graphical User Interface.

The dedicated setup used low-cost Raspberry Pi computer boards connected to the participants speaker systems at home.

One of the main drawbacks of this setup is that neither of these pieces of software strives for a low-latency connection. That is, radio station software prioritizes a stable connection with significant buffering instead of perfect synchronization—which is a very hard problem due to inherent network latency—. In our tests, this caused a delay between selecting a song and for it to stop playing on the speakers as low as two seconds yet observed to extend unpredictably to over a minute. However, upon observing the families interact through the system and given this limitation, we noticed that the delay did not result in a significant negative reaction.

In order to include the various notification and status features that we envisioned, as well as offering an opportunity for future system expansion, we added a touchscreen to each of the Raspberry Pi FamilySong devices. The interface we first implemented was based on

a python server-client websocket-based application that showed the previous, current, and next songs' information on the display, and separated some space for displaying some of the family members' faces. The server kept a log of all actions performed and synchronized each of the displays. This first implementation is displayed on Figure 4.1.
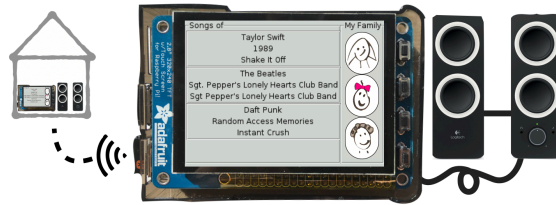
Figure 4.1: The first prototype included rudimentary playlist control and information through its touchscreen interface, as well as a limited area for some of the family members status displays. Each device needed wireless connectivity and access to wired speakers.

Most of the pieces and accessories used in this setup were acquired from and produced by Adafruit. The material aspects of this first distributable prototype were not just influence but rather directly defined by the selection of readily available components: An easy to incorporate credit card-sized touchscreen, and a plastic case with a cover that surrounded the Raspberry Pi along with its touchscreen.

We would later be able to greatly exploit these decisions due to the flexibility that these hardware components and open source software provided. The system was malleable enough to support an implementation that was significantly different in physical properties and supporting more features. These characteristics and features will be discussed in Chapter 5.

4.3   Studying and Revising the Initial Prototype

The implementation distributed to the families had five differences from the one that we initially tested at home. (1) It removed the notification alerts. (2) We separated the toggleable

faces from the semantics of indicating bilateral availability. (3) We removed the bilateral availability requirement. (4) Music selection was expanded by implementing access to the Spotify catalog. (5) We created a separate cell phone/computer interface for managing the connection to Spotify and removed control from the local device.

In jettisoning bilateral availability and control over playing from the local device, but keeping the toggleable faces, we created room for families to create their own semantics of connection.

Adding Spotify complicated the system and the interface(s). Each family group was given a unique web address to manage their song selection and playlist generation through their phones, tablets or computers. Figure 4.2 shows the architecture of the FS system consisting of a server running Mopidy and other subservices, one RPi per household, and a web application to support the faces awareness feature.
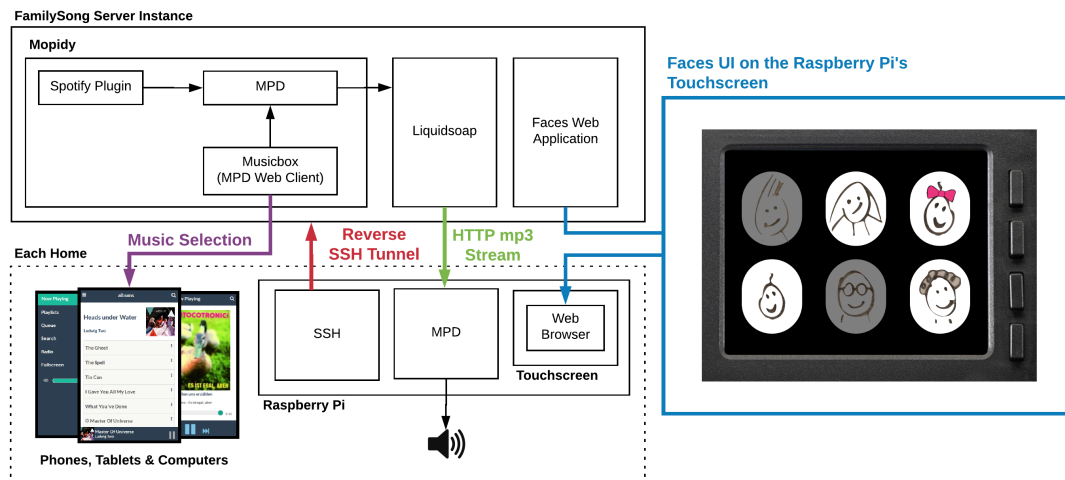
Figure 4.2: Implementation Architecture: The FamilySong Server, a RPi, and the Faces web interface.

4.3.1   Participants and Procedure

We engaged in Research-through-Design by recruiting two family groups: the Abad family and the Valencia family (see Figure 4.3). Both families used FS for a period of two weeks.

The Abad parents (Jorge and Cecilia) and children (Alicia, 5 years old, and Diego, 3 years old) moved to the U.S. for Jorge to study for an MBA. Jorge's parents (Pablo and Ana) participated in this study from Ecuador. The Valencia parents (Antonio and Marina) and children (Miguel and Sebastian, 5 and 3) moved to the U.S. for Marina to study a PhD. Marina's parents (Rafael and Lina) also live in Ecuador.
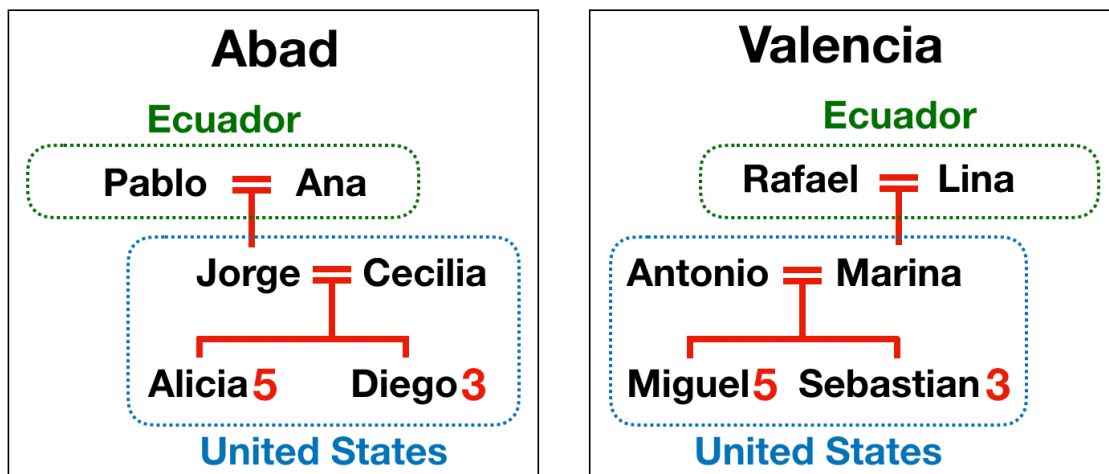
Figure 4.3: Our two family groups: The Abads and the Valencias.

In both cases, we had a chance opportunity to conduct the study just before scheduled vacations that brought the grandparents to visit their relatives. Interviews were performed in Spanish and face-to-face at the families' homes in the U.S.

We interviewed the participants by couples (e.g. one interview for a parent couple and one for a grandparent couple), expecting partners to help each other in building a narrative of their experience with FS.

Analytic Method

The semi-structured interviews lasted roughly 30 minutes. We took notes and recorded audio of the conversation. We requested that participants describe musical habits and tastes through the study period, sharing and coordinating of music, awareness of each other, opportunity for communication, and behavior around the Faces feature.

The audio recordings were transcribed and translated to English. Following standard qualitative practices [12], we analyzed the transcripts by identifying themes and looking for emerging patterns within the communications practices of all three participant groups. Themes were tested and refined by discussion with the lab group. These codes were used to create narratives of use and interpretation by the participants, presented in the next section.

4.3.2   Results from the First in-Home Study

FS met with success in that it was used almost every day by both families during the two week study. Furthermore, the families expressed interest in continuing to use it in the future and even expressed design ideas and directions for the future.

Four themes emerged in our interactions during the study and through the interviews: the ecosystem of technical connections, listening and sharing, culture and family, and awareness through faces.

The Ecosystem of Technological Connections

The ecology of devices and practices in the participants' homes already included heavy use of video conferencing technologies. Primary uses, at various times of the day, were to connect with each other and help entertain the children. The Abad family described habitual

videocalls around breakfast, including turn-taking with the grandparents. Cecilia Abad told us *"[she] would serve breakfast and setup Skype so that during breakfast it would be like [grandma Ana], [grandpa Pablo] and the kids were having breakfast on the same table. At least in theory."*

Ana Abad related that her grandchildren frequently *"did a show"* for them—selecting music and dressing up in costumes to dance and sing to her. Through opening up a Skype connection, they verified the same music was playing and then enjoyed it with their usual singing and dancing. Her son Jorge also indicated that knowing that Ana was listening triggered many "shows."

Video technology was not without problems. Cecilia Abad also reported that, unhappily, video connectivity seemed to spark rivalry in the children in which they would fight to be the the center of attention. Marina Valencia related to us that, due to her busy schedule, it was very hard for her to coordinate with her parents about opportunities to have videocalls. Marina also contrasted the interactions between her children and parents, before moving and now: *"the kids did everything with their grandparents. It was all love, kisses and everything. Now we have to push them to say hi."* Lina also reported that her youngest grandson would sometimes protest and cry about the request that he greet her: *"I don't want to... [let me go]."*

All eight adult participants expressed themselves favorably toward FS as a device that facilitated listening and sharing music. FS increased their mutual awareness. Although, for example, "shows" were not a new occurrence, they happened more often. Video or chat conversations frequently happened specifically due to FS-based awareness. Marina reported texting more frequently with her mom. Often, the purpose was to make sure they were all listening—*"Mom, the music is on. Are you listening?"* To her, this was a valuable connection.

On listening and sharing: a sometimes synchronous activity

Rafael and Lina describe listening to music at home and in the car, having shared many car rides with their grand-children before they left. They now missed these favorite opportunities for listening together. As is often the case in Ecuador, the grandparents had played a large part in the grandchildren's upbringing prior to the move to the U.S. music had been an important part of this. Lina reminded Rafael that—before using FS—they had meant to prepare a USB drive so that he could bring it to their grandchildren filled with their music. With FS, this no longer felt necessary. Lina's feelings about the connection brought through music were particularly powerful: *"We don't want the babies to lose it [the music]. Because they were raised with the music and singing. This [FS] was a way to continue doing that."*

The embedding of music into these families' lives and its frequent function as a form of connectivity was captured in Marina's remark that she and her parents used to play music at bedtime through their cellphones. Now FS–a separate device—made it easier to control. She was also thinking that her parents would fall asleep to the music.

These comments encouraged the FS approach of creating music as form of experience that could exist in either foreground or background relationship to on-going activity and that could serve to cement relationships, even among adults.

The participants developed usage practices. The Valencia's home in Ecuador is a two-story house; Lina said that during the mornings she would come downstairs and find the music playing, remarking: "Marina has put music for the babies... It was lovely to see that the babies were listening to music, and that we could see that." Oftentimes they would unplug the device at night and she would tell Rafael to go turn it on in the morning. At once they would hear the music, affirming that Marina and the children were awake.

Lina also told us that her sister expressed skepticism at the possibility that FS should work

at all: "How is that possible? Such an advanced technology that you are listening to the same music they are? It's very odd." Lina told us she reassured her sister that they had witnessed it through Skype.

Awareness became an important topic that our participants called out directly:

"Jorge: When the device wasn't working, we noticed. It was easy to spot the difference: You arrive home and it's not working. It's something you interact with when you get there. Cecilia: But you still had a topic of conversation.
Jorge: [It's the] presence of the device leads you to that awareness. [It] increases the awareness of the others by a lot. You have this device whose functionality and the setup is shared between both parties. So, for it to work well you always must be aware of whether it's working on the other side, even if you do see it working in your home. "

These are all examples of our participants *themselves* constructing the notion of on-going connection. This sentiment was echoed by both parents and grandparents in both families. One grandparent explicitly called out FS's role, not just as a music player, but in creating connection, commenting *"...that is the gadget where we communicate."*

Culture and Family

Participants reported seeing FS through the lens of culture and family. Throughout the interview, Lina emphasized that she saw FS as a medium for "Family Musical Communication," a term of her own. The Valencias recall with joy several instances of the children yelling: "that's abuelito's [grandpa's] song!'" Lina says of these events: "we heard that and thought that was lovely." These comments built on Lina's integrated thoughts about music, family, culture and their role as grandparents:

"Lina: The most important thing was that there was a musical communication ... That

we, as grandparents and old people, we don't want the babies to lose it. Because they were raised with the music and singing. This was a way to continue doing that. Right? "

All four grandparents were enthusiastic about the proposition made by FS and readily took to creating playlists for their children and grandchildren. All four of them pointed out that the songs being shared instilled a sense of Latin culture that the children would otherwise not experience. They enthusiastically expressed their emotions about FS with superlatives, deeming the experience "fantastic" and "unbelievable."

The parents said less about this explicitly, but it is important to remember that they were the linchpins in making the system operate, that they also listened to the music, and that parents in both families went to considerable trouble to maintain connection across the family through a variety of mechanisms.

Sharing culture and connection was not only just a matter of simply playing music, but also of figuring out what music worked in the situation. Descriptions of the activity of playlist creation revealed how different participants conceptualized hopes and knowledge of others. Grandparents and parents created shared playlists, purposefully to please other participants or with an interest in sharing their own preferences.

Not all music appealed to everyone, but people worked around differences in taste. Grandparents tried to make playlists that would please their children (the parents). One grandmother made a playlist for the grandchildren that a father did not like, but he appeared to approach it philosophically:

"Jorge: As a father, you understand that the grandparent is making an effort to interact. "

FS evoked quite a bit of poetic sentiment in some:

"Pablo: Love must be spread every day. If you don't see them, you start... Falling apart.

Ana: Memory is fragile. "

Our participants tied together notions of important values and of belonging that could be communicated through music:

"Pablo: Music is a learning process. ... You also start introducing in your grandchildren a sense of belonging to something. We are part of something. There's something in common between you and me. "

It is worth noting that, despite the element of nostalgia in this, these families had varied tastes in music, including Ecuadorian and Hispanic songs but also incorporating American and English 80's rock music and jazz in their conversation with us.

The parents were comparatively muted, but still supported these ideas. They tended to phrase their comments more in terms of what they had done rather than the effect it had on them or their family members. Marina said that, especially at the beginning, she focused on creating playlists and playing songs that her mother and father liked and listened to often, recalling "Merengues or songs from Nat King Cole."

Awareness through Faces

It turned out that the Valencia family had put the FS device in a place that the children could not reach. This meant that they did not use the face interface.

However, the Abad family created function and rituals for it.

"Cecilia: I loved that the kids would wake up. They would run to press the faces and say: 'Ah! There's grandpa.' And they would ask me: 'Should I put you as awake mommy?'' They loved the photos, they loved it. They would always wake up and come check them, even if I would've forgotten to do it. Then I would come back and check if they'd done it right. "

The Abad children's use of the faces feature spread through the whole day.

"Cecilia: Diego especially, they always play in this area (living room) and they are close to the machine. They always get tired of a game and turn back to check, they would see the face and say: 'Look mommy, grandpa Pablo and grandma Ana are there, they are there now … They must be listening to our music.' So, though they only checked for a short time, they knew that they were there because they saw their pictures. [Diego] is fascinated by the faces. When it's time for bed, he would be in bed already and get up: 'Mommy, I didn't turn off my face' and he would get up to turn his face off. Sometimes we wouldn't even turn on music or anything, but he was paying attention to the faces and he would say: 'this face yes, this face no.' "

The readily visible information about their grandparents' availability generated opportunities for interaction.

"Cecilia: Alicia loved that when grandma was there she would put music for her to dance for her, because she loves to dance and a do a show … Ana already knows the song and would say: 'what do you think of this one? And this one?' Then she would take out all the costumes, get dressed, hats, do the show for the grandparents. Because I would also turn on Skype so they could do the show. "

"Ana: It was good because they realized when someone is connected because of the faces and they would call me and tell me … Or they would send me a message through WhatsApp and ask me to connect. The same with Pablo, he's there on the faces and they say: 'ah, grandpa Pablo is connected.' You imagine it, of course … Are the kids listening or not? Are they listening to the same music I am? Because you can't always be connected. "

Jorge and Cecilia began to elaborate on the benefits about alternative designs for the faces feature that would provide more agency to the children. Jorge points out that before using

FS they used to play music through an Amazon Echo, and the children would have mixed success in articulating song choices. Such failure was discouraging but they tried. Their first design suggestion was to enable the adults to define a "favorite song" that would be played when a child touched their face. Cecilia indicated that Diego wanted to use the faces to express more complex activity indicators like eating, going to sleep, or being in the shower.

"Jorge: I really loved how the kids interacted with the faces. For them, to have a visual display with which they got to play was nice. Sometimes they played too much ... It's a little sad that they could pick not the music, only say I'm here or not."

Negotiating Technical Problems

Pragmatic aspects of setting and running this system require some thought. The families gave us their Wi-Fi authentication information before we shipped the hardware so the RPi could connect automatically once connected to power in their homes. This required their trust as did the SSH backdoor that we implemented. Both of these helped, especially when Rafael and Lina struggled with setup. Although we were able to rule out some potential causes of problems, at one point we also asked an acquaintance in Ecuador to help them connect the system. At another point, we debugged by Skype-enabled visual and manual inspection of cables and connections.

Slow or intermittent connectivity raised anxiety in the users. Remotely, we could assess problems through our SSH backdoor, explain the issues to our participants and trigger reboots. Our participants would often rely on us to check the system status.

The Abads created a WhatsApp group chat (with all four adults) and added the primary researcher, often using it to request help with technical issues or interface issues. During our interview, Ana Abad indicated that this had made *[understanding the system] easy and*

quick."

4.4   Discussion

The initial motivation for this project was to create opportunities for connection between internationally-separated family members. We saw opportunity in exploring an architecture that stretches the boundaries of research in Media Spaces, especially domestic Media Spaces, and technologies of intimacy. Instead of conceptualizing music as belonging to the individual, we conceptualize it as shared. There are a few other projects in this design space, but none that focus on designing for families or attempt to discover what is important for families.

At a minimum, FS was promising because it was used. Participants reported that FS had an effect in their daily interactions and awareness of the others. Four themes illuminate *how* it was important for the families involved:

The Ecosystem of Technological Connections The families appropriated FS within their own socio-technical systems for communication. The benefits of using FS were both individual (it replaced other listening mechanisms) and motivated by sharing. Connection through FS was both novel and unique (or to use a grandparent's words *"unbelievable"* and *"fantastic"*). FS did not look to supplant existing technology use. It sought to add opportunities and context that could be appreciated in the moment and through other media. In-so-doing, however, it may have subtly influenced use of the other media.

Listening and Sharing Families developed routines and patterns-of-sharing of the music itself, awareness of the other mediated by the music and associated faces, and discussions motivated and contextualized by the music. These moved along a spectrum

between focus and background, and levels of assurance about the attention and experience of remote parties.

Culture and Family Our participants experimented with play-list creation as a means to share both well-established and new music preferences. Most were perceived by other family members as valuable efforts to communicate. The grandparents were especially interested in the ability to present the children with songs that expressed their cultural identity and history. Parents, though less focused on these aspects, seemed eager to facilitate these exchanges.

Awareness through Faces One family's children engaged with the face interface consistently, developing a semantics of use.

These four themes describe elements of FS use that were important to the participants. Implicit in these descriptions were two types of special *moments* around FS use:

Listening to music together Listening to music together (or believing that one is listening to music together) creates a common experience with many levels of feeling and meaning. We claim that it is this that leads to the use of superlatives and poetic overtones in the grandparents' description of the system and the Abad children's excitement and focus on connection through the faces interface.

Recalling shared music After the fact, participants could refer to songs by singing, humming, name, lyric, or playlist in Spanish or English. Music's multi-faceted denotative properties make possible many of the claims our participants make about culture and identity. Music is the vehicle for communication of these values. It also provides the kind of context that Evjemo, et al. [27] called for as a mechanism to support grandparent-grandchild communication including conversation, singing and dancing.

Within this small and select group, the balance between effort and value appears to be regarded as positive. According to the parents the children appreciated the songs being shared by their family members, at times identifying intentions within the selections (e.g., "this is abuelito's song!"). Both groups of adults acknowledged mutual intentions for communication and were happy to find new topics for conversation drawn from the particular songs, playlists and genres that were shared. The Abad family expressed great interest in enabling more agency for the children in the song selection process. Although the grandparents were the most effusive about the benefits of FS in allowing them to share bits of culture, we must emphasize the parents' role in wanting and facilitating these opportunities. Importantly, all of our participants talked about FS in relationship to values and emotions. Its significance was rarely reduced to simple music listening.

4.4.1   Limitations

The work described here is very preliminary. Only three families, 19 people, have used FS, including an author's family and two other families recruited by personal connection. Other families might prove to be uninterested or less tolerant of difficulty. The potential of the system may be limited to certain kinds of families in certain cultural contexts. It is the also possible that the excitement is due to a novelty effect [18] which might still manifest itself in a significantly longer study.

Nonetheless, the work captures some reason to be excited and interested in the design directions. While our findings should not be treated with excessive certainty, we explore some of their implications.

4.4.2   Design Within This Area

In focusing on families, the research uncovers more about (1) the subtlety of the design at the intersection of Media Spaces, spaces for intimacy and music and (2) the kinds of important human values for which we are designing.

Design at the Intersection

Small differences in inter-personal relationship can be associated with importantly different design needs. We originally thought that explicit bilateral symmetry would be important but this turned out to be a burden that limited system use. Therefore, in the second prototype, knowledge of whether shared listening was happening moved to the face interface and participants used social mechanisms on other devices in the ecology.

The exact role of always-on audio is debated in many systems. MissU presents real-time audio connectivity as an option for the romantic couples it targets, seeing conversation as possibly continuous with music and, presumably, assuming that couples can discuss it if they prefer privacy [66]. Pre-teen children might want audio connectivity but CoListen does not provide it, because parents of pre-teen children might not want the distraction of audio connectivity for their children [88, 89, 90]. The designers hope to give pre-teen children *some* enhanced sense of social connection while supporting the parents' perception that CoListen use is consistent with sufficient focus on homework. FS does not offer real-time audio connectivity because it offers too much risk of privacy violations that might be difficult to discuss in inter-generational households.

We discuss this area as a design "space" but it is very important to remember that design solutions are not continuous within the space. A crucial on-going question for the field is what constellations of affordances can operate sufficiently well together to constitute designed

systems. The current work establishes that FS is one such constellation, "satisficing" the complementary and even the conflicting needs of multiple users.

Important Human Values

Moving beyond preliminary viability, an important question to the DIS community has been whether and how systems interact with important and enduring human values [36, 38, 86, 95, 99]. The current work is founded in a concern for such values. Although the families' excitement about the system is likely to abate over time, it is important to note that *they* perceive connection to aspects of being that really matter to them. We were only able to include a few quotes in the findings section that support this, but it is not too much to say that the grandparents were thrilled—and that the parents looked on and supported that excitement with approval, even when they did not like the particular songs chosen.

We have tried to indicate the strength (and therefore importance) of the feelings they expressed through an analogy to *umami*. Of course, we are not talking about *umami* as a component of HCI [44, 80]. We are talking about it as a term that characterizes notions of an embodied, sensory experience, an enjoyment related to completion or fulfillment, that we heard in some discussion of the system.

One power of RtD is to bring our attention to important variations and possibilities of human experience. The analogy of *umami* serves to alert us to the need to populate our understanding of the variety and kinds of human delight and pleasure we address through the design of our systems. We stretch the meaning of this term in order to describe a constellation of important feelings and experiences that the design seemed to touch upon that are not easily described in words.

One way to advance the field is to locate other words and concepts in many cultures that

capture important feelings and values that the community should attend to. Intimacy, a term already used in the field, captures a powerful notion, but there are many kinds of intimacy and associated forms of feelings of satisfaction and fulfillment. The moment of missing the romantic partner that MissU targets is not just bitter but can be bittersweet [66]. Akama [1, 2] has brought the related but very different concept of *ma* into HCI discussion. *Ma* is, roughly, a concept of "between-ness," connoting a shared and peaceful transcendent experience. The Yiddish word *kvelling*—not yet introduced as a value enabled by HCI design—denotes the shared pleasure that parents and grandparents take in the details of their children's existence. Although it means something akin the English notion of "taking pride in", to *kvel* is a deep emotional experience, often almost wordless, only shared with people who are also presumed to share it.

However, whether we have pre-existing words or not, it is important to note designs that have the potential to go beyond the provision of information to touch important human values and experiences.

4.4.3   Future Directions

Several directions emerge from the current research. Obviously, there is a need to gain more experience with FS with more families for longer periods of time. There are also design changes. At the level of local design, these include making the FS box attractive enough so that families want to put it in visible places in their living rooms where children can share more in the activity. Furthermore, although we did not dwell on this in the current paper, parents felt too much responsibility in the midst of their busy days for making the system operate and grandparents too wanted the young children to have more agency. These wishes can be addressed through design. Lastly, a more profound question is, assuming that FS

has a constituency, how wide is that constituency? The analogy to *umami* is an attempt to describe a universal, positive, lighthearted experience. But other important and enduring human values focus on a rawer need for comfort and connection in the face of suffering and desperation.

Other Migratory and Family Separation Contexts

In cases of forced-migration, individuals find themselves destitute of their homes, families, possessions, and are then forced to exists in a foreign context where they do not fit [98, 100]. Various researchers have discussed the importance of developing social capital: (1) within migrant communities, (2) between immigrants and their host countries, (3) and if possible, maintaining links to their past home, relatives, and culture.

What is the relationship between FS and these more dire circumstances? The creation of a shared place is fundamental to FS in ameliorating the feelings of separation between families. We believe that place may also be important to migrants who face more dire circumstances, but it might not be so easy to establish.

We see an opportunity within the design space that includes FS, MissU [66] and Colisten [89] to foster similar feelings of connectedness within these groups. But this is an extremely challenging question. Careful research is required at a pragmatic level to know how to fine-tune affordances. For example, assumptions about public vs. private consumption of music and the relative cost of materials and connectivity may be crucial and may differ from the circumstances examined here. More troubling is the thought that the elements that lead to delight in a secure context may be perceived differently in an insecure context. Instead of offering some connectivity, they may be seen as painful reminders of all that is missing, a kind of cruel facsimile of the wished-for connection.

4.5 Summary

Explorations on the design of FamilySong and on understanding the design space began at my home, through observing the interactions that my wife, my daughter, my parents, my in-laws, and I had when communicating through various video-call and group text messaging systems. My family quickly developed ways to try to address our needs for meaningful connections that, although not always seamless, provided opportunities for engagement with my daughter that were enjoyable at a distance. We based FamilySong on these practices, especially a set of habits around singing, sharing, and enjoying music. The opportunity inherent in our practices was realized through combining music with a Media Space approach. In doing this, we attempted to address a perceived shortcoming of Media Spaces in the home: A lack of privacy.

We tested several initial designs to connect our home and my in-laws' home. Through these Autobiographical Design steps we were able to debug issues with the system, as well as to better understand our collective motivations and interests.

The first deployment at two other families' homes already benefited from significant use and small iterations. In these first explorations we tried to answer whether FamilySong, by itself a music-only experience, could be described as Media Space research. Even if it makes sense to consider FamilySong, by itself, a MediaSpace, in this day-and-age it also entered into a world inhabited by other similar systems. It became part of an eco-system, integrating in to the existing family practices providing added value and meaning to their interactions.

Participating families did indeed use the system during two weeks and in one case have continued participating in the next iteration (the other family moved back to Ecuador). Listening to synchronous music was reported as at least enjoyable and in many cases, deeply moving, especially to the grandparents. Participants in general reported enjoying the ex-

perience, emphasizing increased awareness, new perceived opportunities for communication, and opportunities for participation in the remote household.

FamilySong was used and reportedly enjoyed by these families to listen and share music in new ways than they had previously experienced. Furthermore, as anticipated, the influence of FamilySong expanded into other existing channels of communication. Last, FamilySong permitted opportunities for serendipitous interactions, and some participants even described it as communication (e.g. "This is the gadget where we communicate").

These descriptions by participants provided sufficient motivation for continued work in the field, and began to address various aspects of research questions 1 and 2.

RQ1 What does FamilySong, in combination with an ecology of systems of connectivity, tell us about sustaining significant connections without becoming overly intrusive?

The socio-technical system that developed around FamilySong constituted a valuable addition to participants daily home activities. The greatest negative disturbance was felt by one of the parent couples who felt their attention to the system was heavily required by the children to maintain basic system use; however, this was not described as an invasion of privacy. On the other hand, parents themselves and grandparents specially felt that the "musical connection" was different than the type of communication enabled by videocalls and text messages and in some aspects better since they felt they were contributing to the other household in a small way (e.g., by keeping the children entertained, better connecting them to their grandparents and also connecting to valued experiences shared by parents and grandparents).

RQ2 What does FamilySong tell us about fostering the sharing of music, the knowledge of music, and subsequent interaction around music between family members?

Grandparents were particularly excited about the opportunities that FamilySong afforded them in sharing their culture and identity through music. Both sets of grandparents recalled fond memories of singing or dancing together, and for each other, when together and also apart. FamilySong was able to elicit frequent occurrences of interactions that they identified as similar to or the same as dancing and singing together, at least during the short period of time that the families used it. Family members also reported an increase in the number of times that they had talked specifically about music, cherishing it as a worthwhile reason to have a spontaneous conversation.

However, there were issues and limitations in the designed socio-technical system. In particular:

- Children enjoyed the small amount of agency that toggling the family's faces provided but could not easily make song selections on their own.

- Parents were often busy at the times the children wanted to use the system. They were willing and wanted to help the children use the system but they were not always available when the children wanted.

- The boxes had certain limitations. They had to be placed near existing speaker setups because we were using the participants' speakers. Also initial connection to the speakers was difficult for some families. We wanted the boxes to be accessible to the young children, but the attached cables and accessories mandated that it be located around the TV cabinet in one house and the parents were concerned with the children messing with the cables.

- Grandparents, children and parents sometimes had different taste and listening practices. This particular group of users saw the opportunity to negotiate these differences as a positive chance for more engagement. That was deeply encouraging but did not

close down questions about when and to whom this system would be seen as a contribution.

Satisficing across different users, but enabling shared experience and emotion help define what it means to *connect like a family.* The difficulties we encountered, and need for a better of understanding of how families interact at a distance, helped us redefine our scope of inquiry to include how FamilySong was influencing family dynamics and individuals' agency. A large portion of this agency question was oriented towards providing children a way to express themselves through FamilySong. Research questions 3, 3a, and 3b became a new focus of attention in our research and design inquiry:

RQ3 What does FamilySong tell us about balancing expressions of control and agency, musical taste, and communication by all family members in this design space?

RQ3a Can we decrease demands on the parents in a way that does not sacrifice privacy, mutual enjoyment, or quality of the experience?

RQ3b Can we increase the children's agency, enjoyment, and ability to interact with adults, without sacrificing privacy, mutual enjoyment, or quality of the experience?

In the next iteration, described in Chapter 5 we aimed to address the issues uncovered by this first study.

Chapter 5

Studying Families and Changing Family Dynamics with FamilySong

In this chapter we continue describing our research and design journey, which began as a series of Autobiographical Design explorations [**?**] described in Chapters 1 and 4, continued with a Research-through-Design methodology [106] involving a small-scale study which is the main focus of Chapter 4. This effort reported in this chapter is an attempt to address several broad and specific concerns elucidated by our work and also to test whether the findings replicate over a longer period of time and with more users.

To summarize our prior findings, the synchronous playback of music between two households demonstrated the potential for providing a shared experience that satisfices various needs and motivations for connection between loved ones at a distance. The experiences provided by FamilySong were found to be generally enjoyable by all participants, even though some parents expressed a small level of distress at feeling pressured to choose music for playback— the parents did not mind the work of queuing the music, but they did mind the lack of agency over when the requests arose—they still considered the experience valuable and were eager to facilitate it. Grandparents were specially enthusiastic and emotional about the opportunities for connection and interaction FamilySong provided.

In this second large step, we wanted to begin to address a concern about the small number of families in the prior study, the validity of our findings being affected by a novelty effect

and a design tension existing between, on one hand, the desires of all participants to choose music for playback through the system, and, on the other, overwhelmed parents who were frequently interrupted by children and sometimes even grandparents to queue music.

Secondary design objectives that nonetheless seemed to greatly affect the experience included an aesthetic component, where the original small plastic box was not seen as an object to be foregrounded around the house—and was therefore stuck behind the living room TV in one home, diminishing the children's access.

The outcome of these concerns was a significantly different design proposition. The presentation to the users evolved in a substantially new direction, partially inspired on the object-naming game that Emma had played earlier with her grandparents. The main insight was that even children as young as 18 months could handle physical objects that signified songs and were likely to enjoy the agency involved in playing the music themselves. Their ability suggested a design focus that utilized physical objects.

Provision and management of what we call *CardSongs* became a central focus. The idea was that a physical object (an NFC card or tag) would trigger the playing of a song once detected by the new FamilySong device. This drove changes to the underlying software and hardware architecture. Parents and grandparents needed manageable ways to assign meaning to CardSong objects. It also engendered quite a large shift in the user interface to accommodate the physical cards. Last, we continued to tinker with what information should be present on the device's touchscreen, which on the last study only presented the *Faces* interface.

These goals created opportunities for radiating design discussions:

- Since the CardSongs were designed for children, should Grandparents have the same or different interface to the system? Would parents want a more sophisticated interface

when using the system themselves than when they used it with their children?

- Should CardSongs be mirrored between locations so that new songs could be automatically reciprocated, that is, if a child chose to play a particular song, the grandparent might want to initiate another interaction with precisely that song. This posed pragmatic problems because (a) someone had to assign meaning to the physical card on both sides and (b) decorations on a card might all of a sudden not match the song they were intended for, causing confusion.

- We continued to balance how much information should appear on the small touch screen. The first prototypes of FamilySong emphasized the song queue, to the detriment of making faces too small to accommodate young children's coordination. On the deployed short study we focused on showing the family's faces only. With the emphasis on CardSongs we believed that a new equilibrium was necessary.

We inferred that the simplest system would be one that was the same whenever possible for all users, whether children or adults; however, we did not see a way to allow young children to create cards unassisted. On further thought, even this potential shortcoming could be framed positively as allowing the adults a degree of content curation (that is, which songs are allowed). Therefore, the component that let people assign songs to cards could involve a cell phone as well as the household's FamilySong device.

Through this new interface, we envisioned an opportunity for adults to make new songs available through the system, either with children or by themselves, at convenient times separate from playback.

5.1   Redesigning FamilySong

This study continues the element of autobiographical work that was part of the project from the beginning [76, 77, 79] but continues to build. It also continued with research-through-design, treating the current design as provisional. In the tradition of research-through-design and design probes [39, 40, 106, 107], it investigates whether the prior findings about shared music replicate and extend to a larger participant group over a longer time, and what changes to experience and behavior with the system are caused by these very significant design responses to the prior work.

The research questions driving the previous study, and which continue being of present interest, were:

RQ1 What does FamilySong, in combination with an ecology of systems of connectivity, tell us about sustaining significant connections without becoming overly intrusive?

RQ2 What does FamilySong tell us about fostering the sharing of music, the knowledge of music, and subsequent interaction around music between family members?

RQ3 What does FamilySong tell us about balancing expressions of control and agency, musical taste, and communication by all family members in this design space?

The first two research questions were of great concern on our first steps in our design journey, they focus our design objectives around two not orthogonal axes. Our efforts up unto this point validate, in as much as this is possible with the small number of users, our theoretical conceptions for a domestic Media Space that uses synchronized music as its medium for connection.

On considering what our research goals for this next step, we further elaborate RQ 3 as:

RQ3a Can we decrease demands on the parents in a way that does not sacrifice privacy, mutual enjoyment, or quality of the experience?

RQ3b Can we increase the children's agency, enjoyment, and ability to interact with adults, without sacrificing privacy, mutual enjoyment, or quality of the experience?

The first and most readily noticeable change to the FamilySong devices corresponds to their physical appearance and material properties. The second change pertains to the introduction of CardSongs and their affordances.

The software side of these features required writing new code to run locally on each device's Raspberry Pi, a significant re-design of the system's database and server-side architecture was necessary. See Figure 5.1 for a diagram of the software and hardware components.
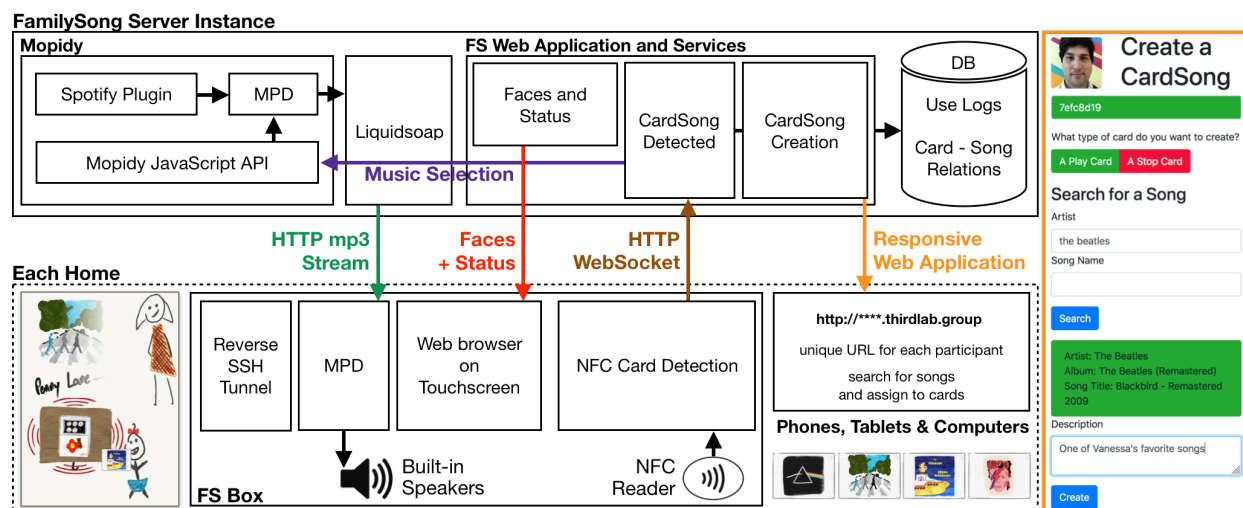
Figure 5.1: The music streaming aspect of the FamilySong architecture remained mostly the same as before with the Mopidy and Liquidsoap components providing each Raspberry Pi with an HTTP mp3 stream. Music selection is no longer available through a web interface but rather through the use of CardSongs. A significantly redesigned and much larger web application and database was implemented to handle the CardSongs feature. The figure also shows the "FS Box" as now containing speakers and the NFC reader.

5.1.1 The Physical Boxes

Pragmatically, adding the new hardware components required a significantly larger device made out of custom pieces with no commercially-available alternatives. In order to properly display the new affordances of the CardSongs feature, it became even more important for children to be able to access the boxes by themselves. Therefore we needed to make the boxes attractive and sturdy enough to occupy visible places in the shared part of the house. An additional design consideration was that some of the adult users had difficulty connecting the previous boxes to their stereo systems. We decided to make the system simpler and easier to deploy by building speakers into the boxes.

We made a design conjecture that giving the boxes handmade quality would convey the idea that they were intended for public display. Bespoke wooden enclosures could be attractive, seem sturdy, and give us complete control over the internal space to house the additional electronic components for the new features (an NFC reader, an audio amplifier, the speakers, and a built-in power supply).

We iterated over several box designs, and ultimately, settled on a size and shape that could sit comfortably on a small side table, with downward firing speakers. With the speakers pointing down, their delicate membrane would not be as exposed to small fingers and objects. We also hid the volume control underneath. These decisions additionally foregrounded the affordances meant to be widely shared, that is, the screen with faces and other information and the places for the cards.

Figures 5.2, 5.3, 5.4, and 5.6 provide a glimpse into the design and prototyping of the boxes. Getting the right materials was quite a challenge. We started with a wholly 3D printed box (not shown) but concluded that it looked and felt too cheap for display. Getting an acceptable balance of materials, size, finish, audio quality, sturdiness, reliability and

constructibility took more than 14 design iterations across a span of two years using several building techniques and materials including electronics, laser cutting, 3D object design, 3D printing, and traditional fine woodworking.
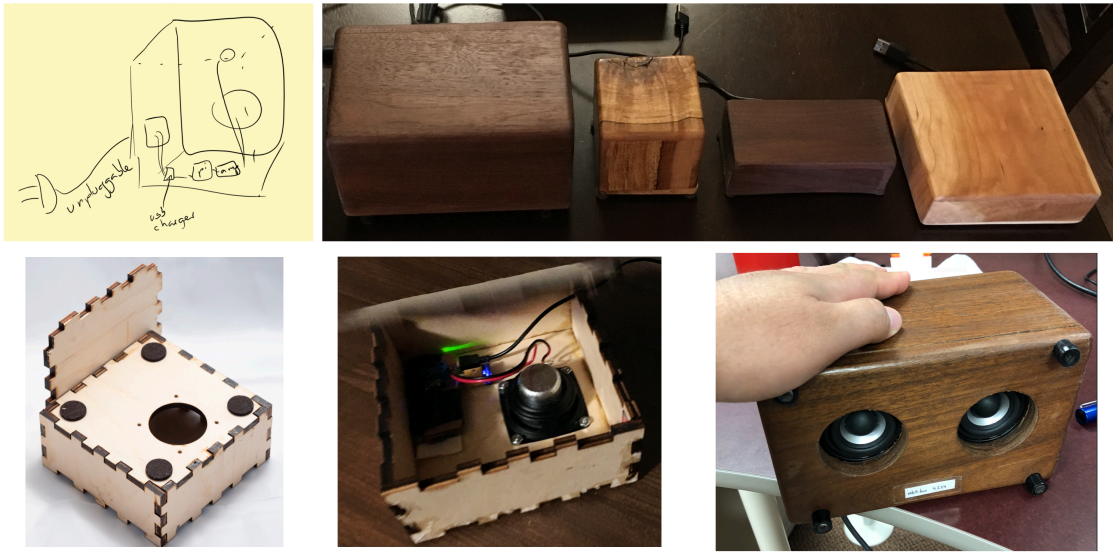
Figure 5.2: The first prototypes for the new FamilySong box focused on exploring form factors, materials, and components. A first rough implementation used an off-the-shelf speaker that we modified to fit a Raspberry Pi with an amplifier. Four of these boxes were created with the help of a local woodworker using local hardwoods, another one was created by laser cutting a piece of plywood.

The touchscreen of the box was mostly dedicated to the same interface used in the previous design, when not playing music the images of family members' faces are the only visible elements in the screen. Just as before, the family's faces can be toggled at either end, independently from the playing of the music. Three changes were made to show the current song's artist and title, and also which house had a card on top of the box at the moment. These changes can be seen in Figure 5.5.

To date, we have created fifteen of these FamilySong boxes. The first six were used by my family, a colleague's family from the United States, and the "Valencias" who had participated in the first study and indicated continued interest. Six more were eventually given
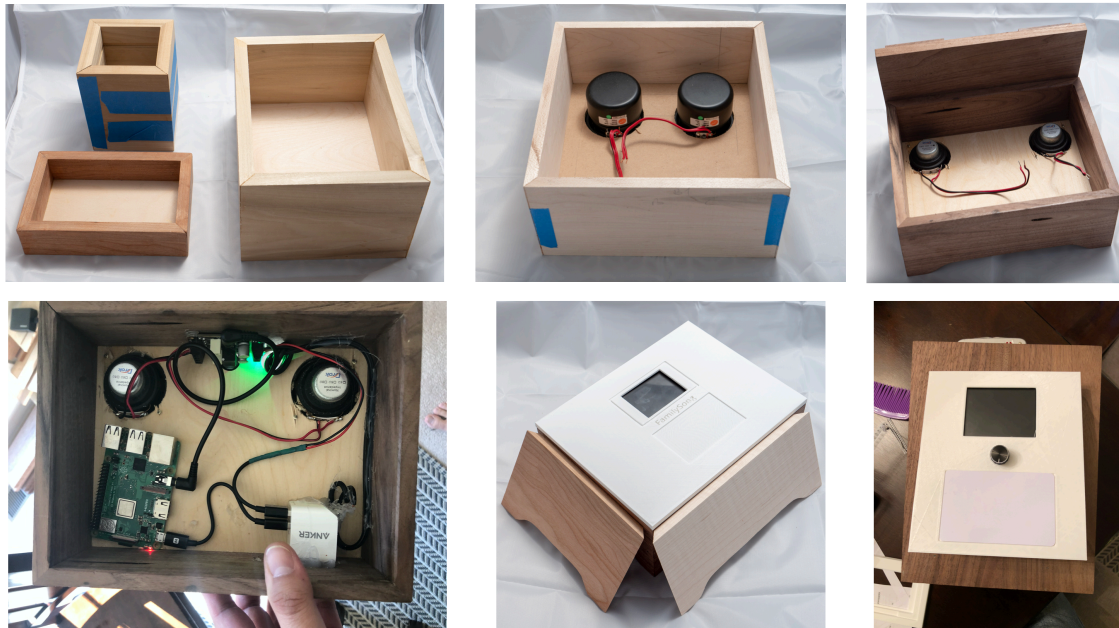
Figure 5.3: For the next set of larger-scale prototypes I collaborated with a friend and local artist to design and create a wooden enclosure using traditional fine woodworking methods. Two box sizes were created, A small one (roughly shoebox size) with 2 inch speakers, and a large one (square with about twice the internal volume) allowing for 4 inch speakers. We incorporated 3D printing into the process in order to better fit the touchscreen controls on top of the box and again experimented with several approaches that would communicate what interaction opportunities the box offered.

to three families new to the study. Finally we built three more boxes to pursue other user constituencies for future work. Figure 5.6 shows one of the finished boxes in a family's living room.

5.1.2 Designing CardSongs

Greater accessibility—and expressivity!—was provided in the form of a new NFC-based interface which we named *CardSongs*. With a CardSong, any user (even house guests! with minimal instructions) can easily make music selections by placing the desired NFC-enabled object on top of the FamilySong box. Figure 5.7 shows a storyboard with a grandparent and
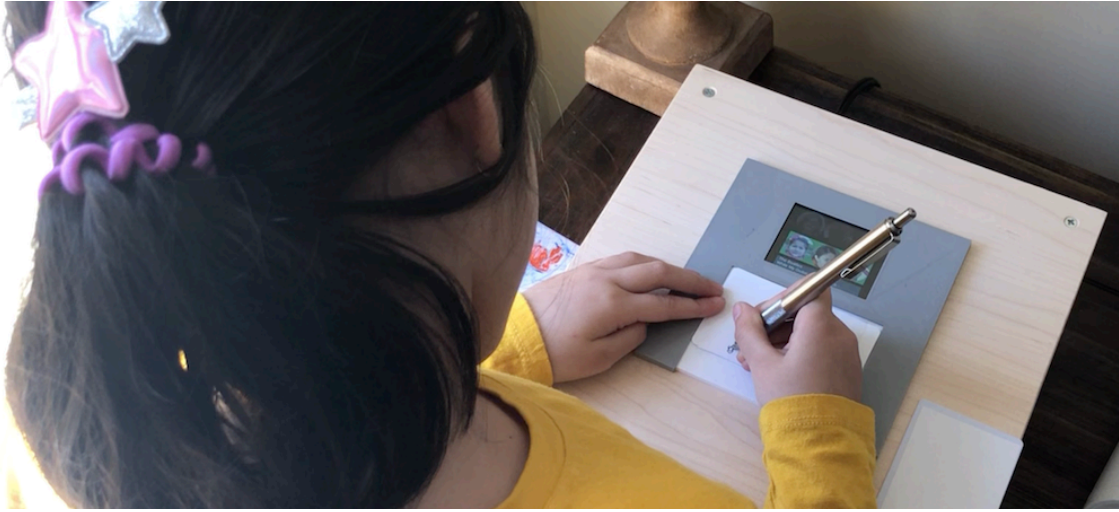
Figure 5.4: This picture shows the box my family kept. Large boxes were more expensive to ship so we installed the other one locally as well.

Figure 5.5: Faces are now organized in two rows: the bottom row always shows *my household*, that is "me and my parents" from a child participant's perspective, while the top row shows the other household (the granparents in this example). At the bottom of the screen the currently-playing song's artist and name is shown. If a card is located over one the boxes, a green rectangle is drawn behind the corresponding household's faces.

Figure 5.6: A FamilySong box in its intended location at one of our participant's home. This family's CardSongs can be seen stacked in front of their box.

her young granddaughter taking turns choosing songs through the cards. On acknowledging detection of a card, the box produces an audible click sound and sends a message to the FamilySong server indicating which CardSong should be added to the music queue. Using a simple web interface, participants associate a single song to a NFC-enabled object. We provided each home with 40 credit-card sized plastic NFC cards, 20 NFC sticker tags, and an assortment of white labels and color markers.

Adult participants were taught how to create CardSongs by accessing a unique (for each participant) web address using their phones or computers. The responsive web application leads participants through five simple steps in order to associate an NFC object to a song from the Spotify catalog. Figure 5.8 shows a nearly-finalized CardSong creation process. The five steps are:
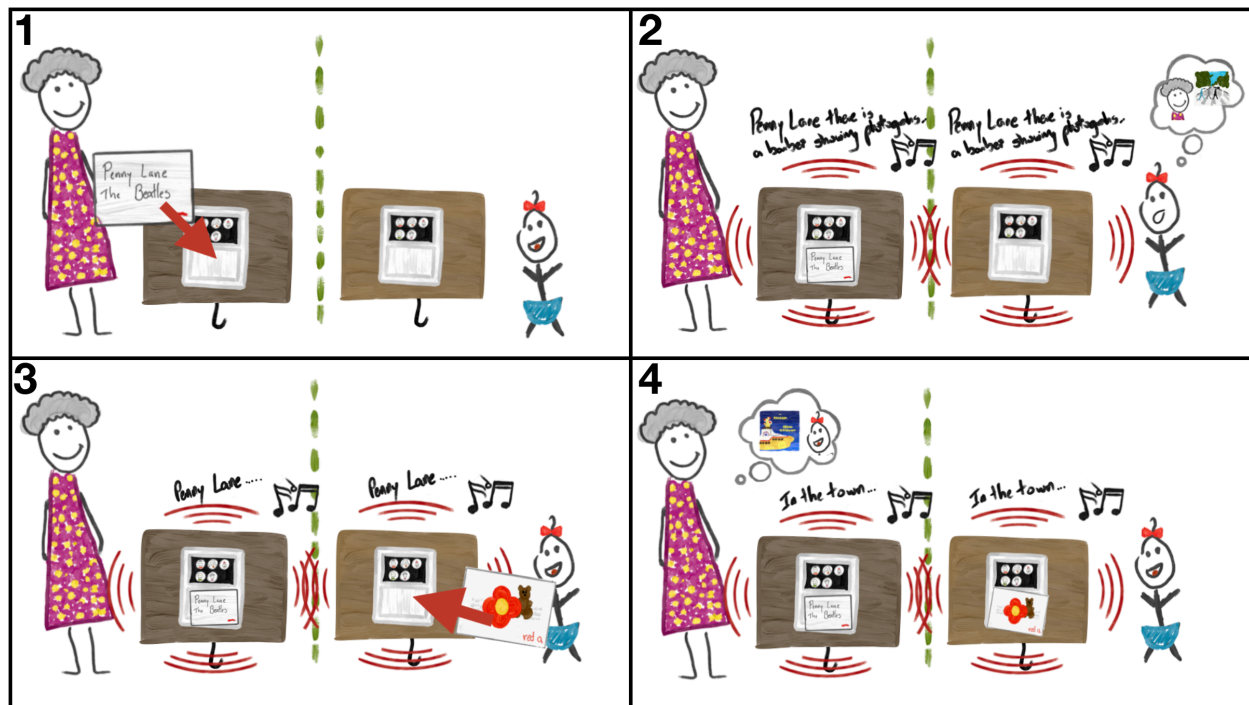
Figure 5.7: Using Wirelessly-Connected (NFC) CardSongs, even two-year-old participants were able to interact with their remote relatives by choosing songs.

1. Upon opening the unique URL, the participant is greeted with the same picture of their face that we present in the Faces interface, and a request to place a card on top of their box. Upon placing a card, the next portion of the interface is revealed.

2. Two types of CardSongs can be created. Creating a Stop card finalizes the process successfully after pressing the red button. Pressing on the green button reveals a search form.

3. Searching for a song can be performed by typing an artist, a song's name, or both.

4. After a search has been performed over the Spotify catalog, the top 10 results matching the search terms are displayed.

5. Pressing on a song hides the rest of the search results and presents the user with

an optional textbox meant for describing the motivations behind the creation of this
CardSong and the final "Create" button.

Figure 5.8: Users can create cards using a responsive interface on their phones or computers.
Each participant received an individual URL to access the system, which ties the process to
their box.

After creating a new CardSong, participants were advised to test it and decorate it by

using the provided adhesive labels and markers. Decorating the cards was suggested as a way to make them recognizable by the children. We anticipated that participants would draw pictures reminiscent of album covers or other representative and identifiable graphical representations of the music associated with each card. Figure 5.9 shows some drawings we made in the design ideation phase leading to CardSongs, used in several of our storyboards.

Figure 5.9: Purported drawings that a participant could attempt to make in order to make a CardSong recognizable without text.

Upon testing several rough prototypes of the NFC interface, and different hardware components, we verified that using CardSongs to select music on the system required very little fine motor skills for (1) grabbing a card, and (2) placing it or even just sliding it a few inches above the sensor-area of the box.

Three important provisional design decisions were that (1) anticipating children's short attention spans, each card corresponded to exactly one song or movement in a composition; (2) concerned about children's propensity to play the same things repeatedly, a STOP card could be deployed to stop the current song, even if that song had been enqueued at the other end; and (3) queues could be created, and contributed to, at either end by swiping one card while others were playing.

5.1.3   Summary of Redesign

The current work replicates and extends that research, offering a new design that addresses these issues with three significant physical changes to the devices:

- We built bespoke wooden enclosures for the system that embedded the components, to make the system aesthetically fit along other objects and decorations in various locations of the home.

- We included built-in speakers so the box did not depend on external equipment.

- We added an NFC-based system so that (very) young children could use physical cards to select and play music. Putting songs on particular cards and decorating them so that they could remember which cards played different songs had the potential to become tasks that parents and children could do together in moments other than when using the system to play music.

5.2   Recruitment and Participants

We recruited six "two-site" families (12 grandparents; 12 parents; 9 children) online and through personal contacts to participate in a three-month study. To be eligible to participate, families needed to: (a) have very young children, (b) have 2-sites (far-away grandparents and parents living with the children), (c) be interested in connecting through music, and (d) have sites located at most one time zone away from each other.

To maintain the anonymity of our participants we refer to each family with a capital letter (A through F). The parent+children households will be marked with a number 1, and grandparent households will be marked with a number 2. For example, house A1 and house

Families	A	B	C	D	E	F
Children's Ages	7, 5	6	3	3, 0	5, 3	6
Days Deployed	173	192	181	170	182	123
Days Active	60	156	131	109	32	20
Cards Played	641	3108	5240	1116	373	203

Table 5.1: The participating families (A-F) have been living with the system for over 4 months, some for longer than others. Days active indicates the number of days that at least one card has been played at either home of that family. Cards played cumulatively shows how many cards were used by that family during the study.

A2 created 38 and 15 CardSongs respectively. Collectively, family A has had 60 active days, that is days within the deployment period where at least one song was played through the system. The members of family A have interacted with the system by placing or swiping CardSongs 741 times. For a similar summary of the families activities see Table 5.1.

We intended for all of the families to establish a connection between their two homes. In all cases, parents and children lived in the East Coast of the United States, and the grandparents lived in Ecuador (A, B, C, and D), Mexico (F), and the United States (E's grandparents are retired Americans, live in the U.S., 6 hours away by car). In broad terms, the participants are Hispanic (with the exception of family E, and the father from family F).

Grandparents' ages are 60-80, parents' 25-50, and children's 2-7 (and a newborn).

Although not a criteria for recruitment, all six families included married parents and married grandparents.

Three special circumstances surround families A, B, and E that may have had an effect on how these families interacted with each other, with- and through the system:

- Family A participated in an earlier study by connecting A1 with their maternal grandparents. The family suggested that this study try to connect them with the paternal grandparents to see if there were any significant changes in the interaction; however,

shortly after deployment a close relative from A fell ill, causing the paternal grandparents to be mostly away from home. Initially, the family's maternal grandparents were visiting A1 in the United States but opted to become A2 once they moved back home. Deployment of the system is counted from the first day A1 had the system enabled, until the time of writing, even though deployment at A2 occurred significantly after. The family was able to conduct some CardSong creation activities while co-located.

- Family B is my family, involved in Autobiographical Design activities.

- Family E is a colleague's family, also engaged in Autobiographical Design.

Participation in the study required a complex family structure, some patience with a technology in an early stage of development, and family-wide commitment over a long period of time. At the time of writing most of these families have continued using the system for over six months and have expressed interest in on-going participation.

An approved informed consent procedure was followed to gain consent of all adult participants. However, participation is a complex issue when a distributed family must make a decision, so on-going participation by different family members is a question of on-going interest.

5.3 Data Collection Plan and Analytic Approach

Data consist of (1) logs of system use at each site, (2) semi-structured interviews conducted every two weeks with each site, as possible, and (3) recordings of video or text interactions that the families use to communicate about the system or to communicate with the primary research about problems with the system.

Most interviews were performed in Spanish and through a videocall service, with only three of the adult couples preferring to do them in English. Interviews were recorded using a Zoom H2n audio recording device, which provides a degree of stereo separation and was located between the computer or phone hosting the videocall, and the interviewer. Initially, the setup was focused around a videoconferencing system called Gruveo that could be accessed using a web URL and did not require the users to create an account or install an application. However, Gruveo had a monthly subscription fee and all our participants were readily happy to accommodate us within their already existing videocall practices using Skype, Facetime, Google Hangouts, or Facebook Messenger.

I transcribed and translated the interviews into written English using two programs:

f4transkript A simple transcription software that permitted us to load the audio-recording of the interview, observe its wave representation as we listened to it, and input timestamps whenever necessary.

Dragon Professional Individual To be able to dictate instead of type the contents of the interview.

We generated transcripts in English for all our interviews, with transcribing and translating being performed as a single step when working with interviews conducted in Spanish. We utilized a technique called *parroting* for transcribing using dictation software, where the transcriber essentially repeats every word heard in the recording. Therefore, we adapted the plain parroting technique to include the translation step.

We were eventually able to reach close to 1:1 transcription times (1 minute of recording taking us 1 minute to process). Compared to our previous performance of closer to 1:3 this dictation-based approach was significantly superior. Additionally, transcribing even for long periods of time did not incur in physical fatigue.

The qualitative analysis of the data was performed using f4analyze, from the same company the transcribing program was licensed from. f4analyze loads the transcripts exported by f4transkript into a project, and then provides an interface for creating annotations and codes within each transcript.

Following qualitative practices similar to those in the earlier study ([12]), the plan was to analyze the transcripts by identifying themes and looking for emerging patterns within the communications practices of the participant groups. However, reflecting the later stage of the work, we would start by inquiring whether themes previously identified recurred and whether participants expressed similar ranges and kinds of view about them. The intention was also to note discussions related to the particular new elements in the system, including the boxes, CardSongs, children's activities, and how children's agency influenced the experience of the system as a whole.

The plan was to develop a coding system and continue to refine it as need. Indeed, a first open-coding pass with f4analyzed was performed using the first few interviews. Every utterance, or group of utterances was coded, excluding greetings, conversations in which we installed and debugged the system with participants, and unrelated topics of conversation. This first group of open codes used phrases drawn from the prior study and utterances represented, occasionally edited for conciseness.

On a second pass, we conducted axial-coding, finding commonalities between the codes we created on the first step and beginning to define a hierarchy of codes.

Subsequent coding steps utilized both the open-codes and the hierarchy as appropriate. In general, utterances were directly assigned to existing codes that matched them well. Other codes were added as needed. Particular themes are presented as findings, below.

5.4 Findings

5.4.1 Overview of FamilySong System Use

The usage logs have been processed lightly to provide us with a perspective of use over time. Figures 5.10, 5.11, 5.12, 5.13, 5.14, and 5.15 show CardSong usage over time, with the date (day, starting from deployment) on the horizontal axis, and the time on the vertical axis. Each colored symbol represents a card being used on one of the two houses. The circles correspond to card uses at a parent-children house, and the triangles are actions at the grandparents house.

A few pieces of information about usage by families are readily identifiable in these graphs.

Most graphs show that families seem to be using the system between 7am and 9pm. There is some sporadic use outside of these hours but it is very rare. We surmise that most families did not think it appropriate to listen when others are sleeping.

Some participants, like Father E corroborated these concerns:

"It must've been in before 8 o'clock maybe even before 730. And [father-in-law] is definitely not awake at that time [... and] it's like crazy town 90s dance [...] And I'm just like 'oh no'"

Dotted horizontal lines have been drawn at 7am and 9pm, roughly describing the time window of use.

Wherever appropriate we have annotated characteristics of use that seemed particularly relevant, describing them in the graphs' captions.

Summarily, the usage data does show some patterns of use and it is possible that collection over a longer period of time may help in triangulating the information we gather through the interviews. Attention to when the other family might be asleep helps defines the balance
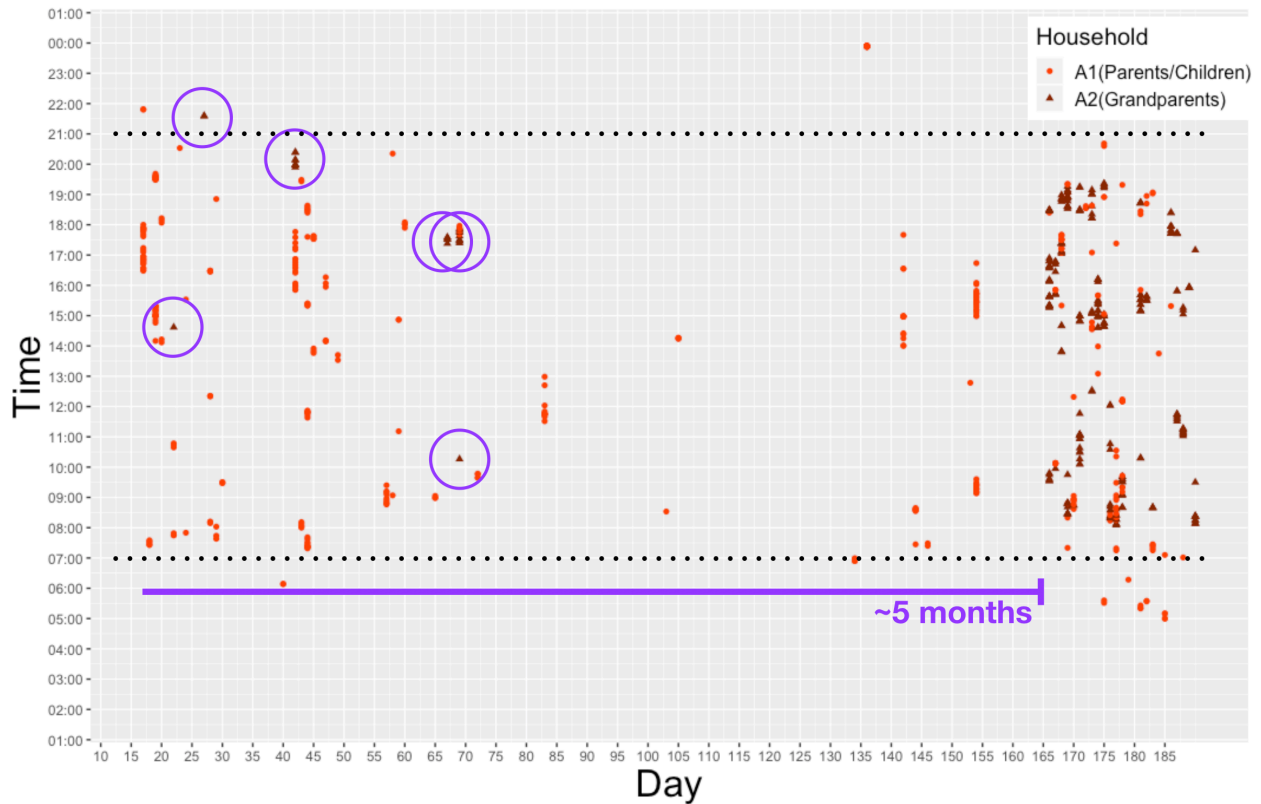
Figure 5.10: Home A1 (parents and children) was connected at first with Father A's parents. Due to personal circumstances they were unable to use the system and after around 5 months of non-use decided to hand their box over to Mother A's parents. FamilySong use notably increased with the maternal grandparents.

between personal and family-oriented use. Whereas some might use FamilySong as a personal listening device during the day, most would not treat it that way when others could be sleeping.

Overview of FamilySong Card Creation

Participants have created 420 CardSongs to date. Excluding researcher family B (who has a significantly higher number of cards) the average number of CardSongs per household is 22 and they averaged 17.35 songs played on active days.
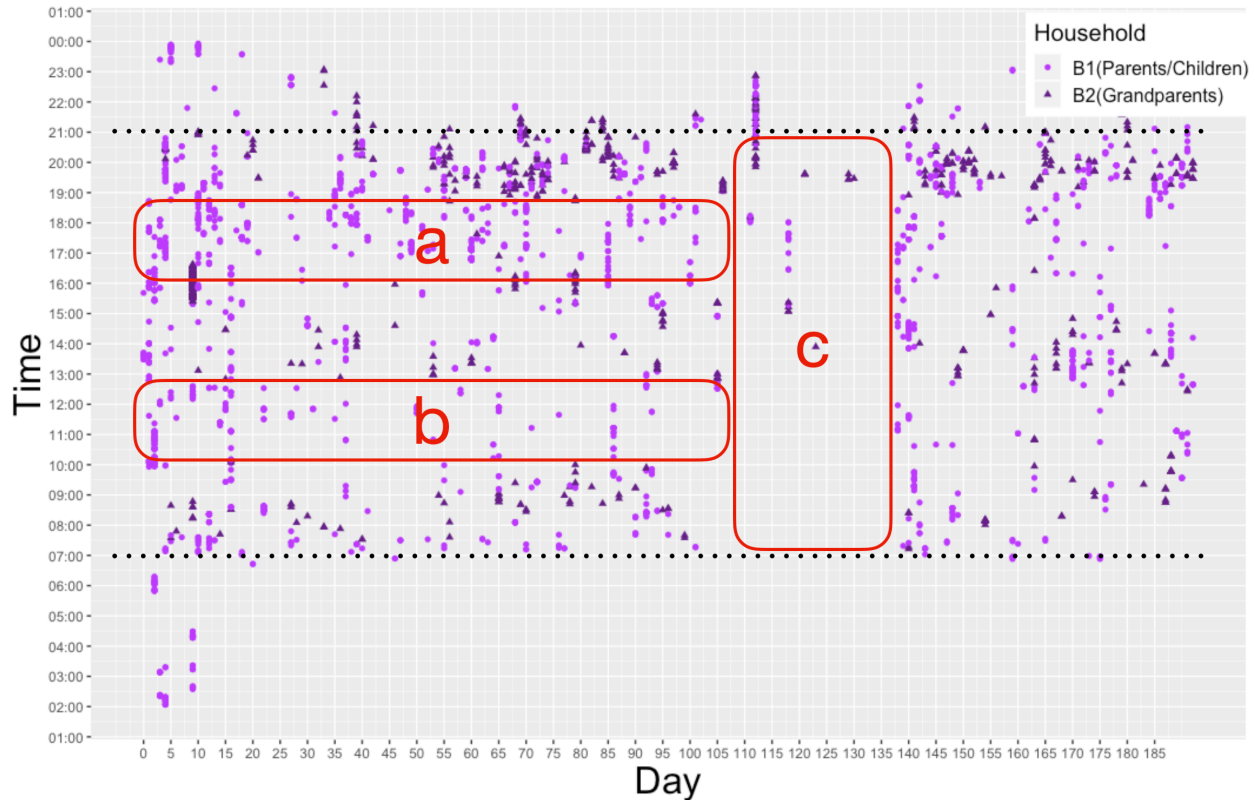
Figure 5.11: Family B is my family. My parents consistently conduct their office hours roughly from 10am to 1pm, and again from 4pm to 7pm (areas a and b in the graph show these windows of time). In these time periods there are no song selections made in B2. Usage picks up after 7pm when both households are at home, after 7pm. Area c corresponds to roughly a month, where us (B1) were migrating back to Ecuador and did not have our box operating full time, with only about 4 moments of use. The salient peak of high use in c corresponds to our demo presentation at the Designing Interactive Systems Conference of 2019 [96], where the data shows use between 8pm and 11pm EST but the boxes were operating in California, roughly from 5pm and 8pm PST.

CardSong creation over the timeline of family system use in shown in Figures A.1, A.2, A.3, A.4, A.5, and A.6, in Appendix **??**.

We observe that CardSongs are not created or updated daily. When they are created, participants tend to create more than one CardSong at a time, suggesting that they have creation sessions.
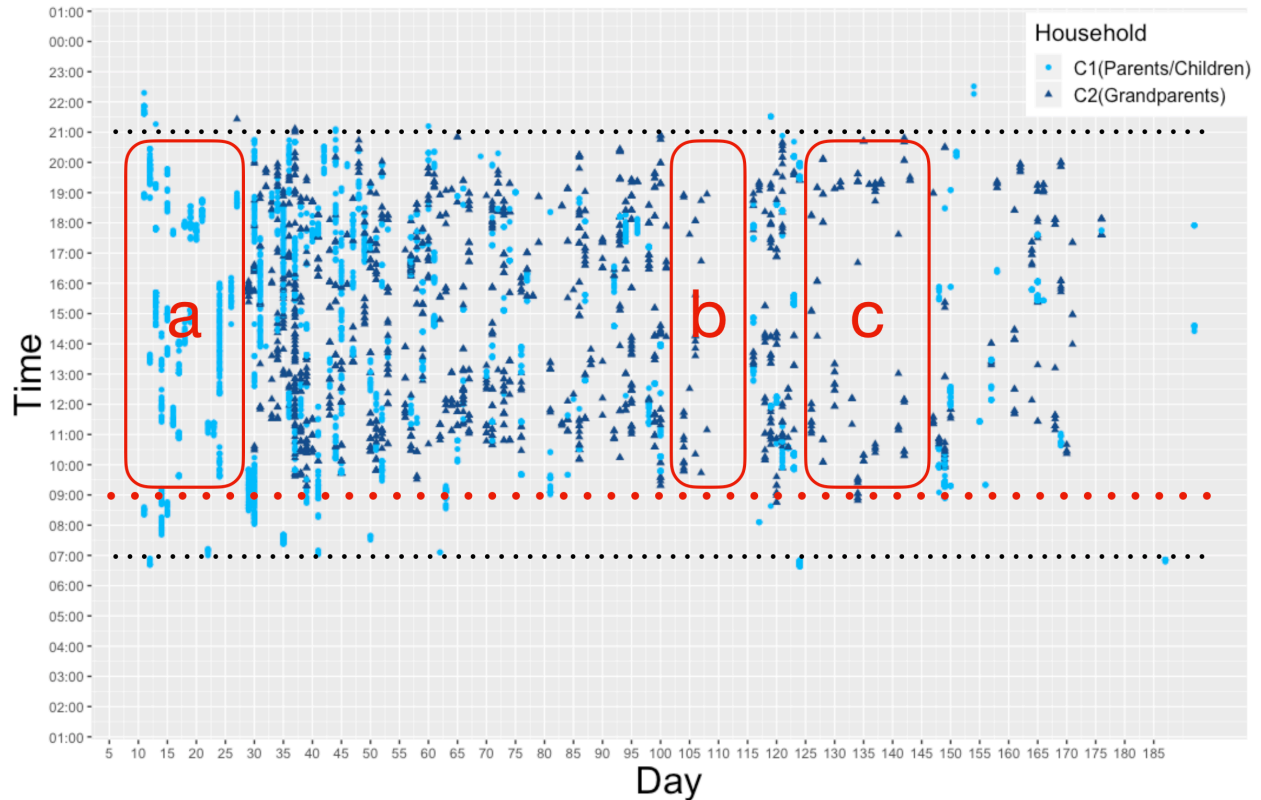
Figure 5.12: Family C had the unique characteristic of the grandparents managing and staffing a shoe store, spending most of their weekdays and weekend there. We have added a red dotted line to emphasize that there is almost no interactions started by C2 before 9am when they open the store, and none after 9pm when they have gone home. Additionally, there are three periods of inactivity perceived in the graph: (a) Until around day 27, the grandparents had not received their box, (b and c) Between days 100 and 115, and between days 125 and 150 the parent-child home did not have an internet connection.

5.4.2   Interview Data

Sixteen total hours of interviews were gathered from 32 occasions with six families. There were different numbers of interviews from different families because of schedules and availability. Adults at different sites were interviewed together, so that parents were interviewed together and grandparents were separately interviewed together. As with the previous study, children were represented indirectly through accounts given by parents and grandparents.
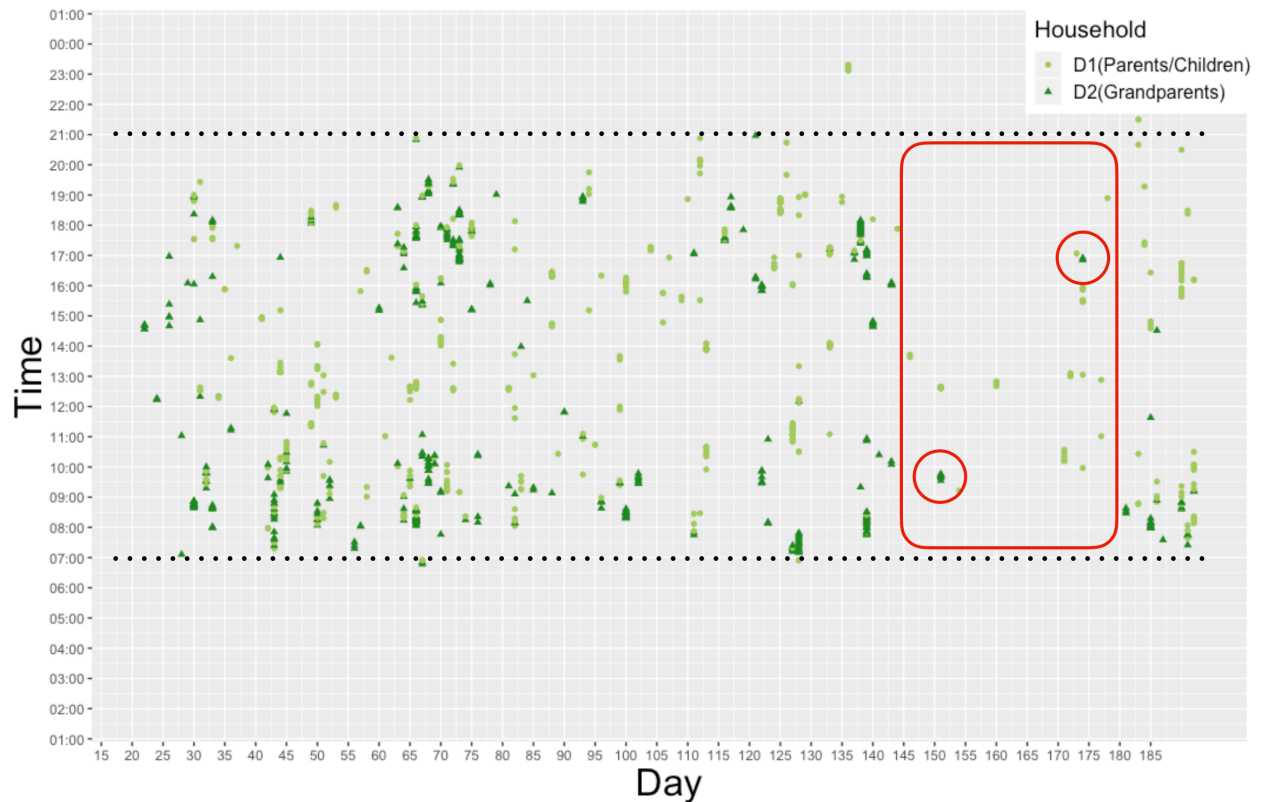
Figure 5.13: Family D's interactions halted between days 145 and 180, when the grandmother reported she was on vacation visiting one of her sons for over a month. In this period of time we see only two song selections from D2 which must come from the grandfather who reportedly stayed at home.

We asked participants to: (1) share anecdotes that occurred around the use of our system; (2) describe how (or whether) the presence of our system had changed the dynamics of communication between their families; (3) recommend design changes to the system in order to affect perceived issues.

Interviews were conducted in Spanish for the Spanish speaking households and in English for the two English speaking households. All interviews were transcribed and the Spanish ones translated to English.
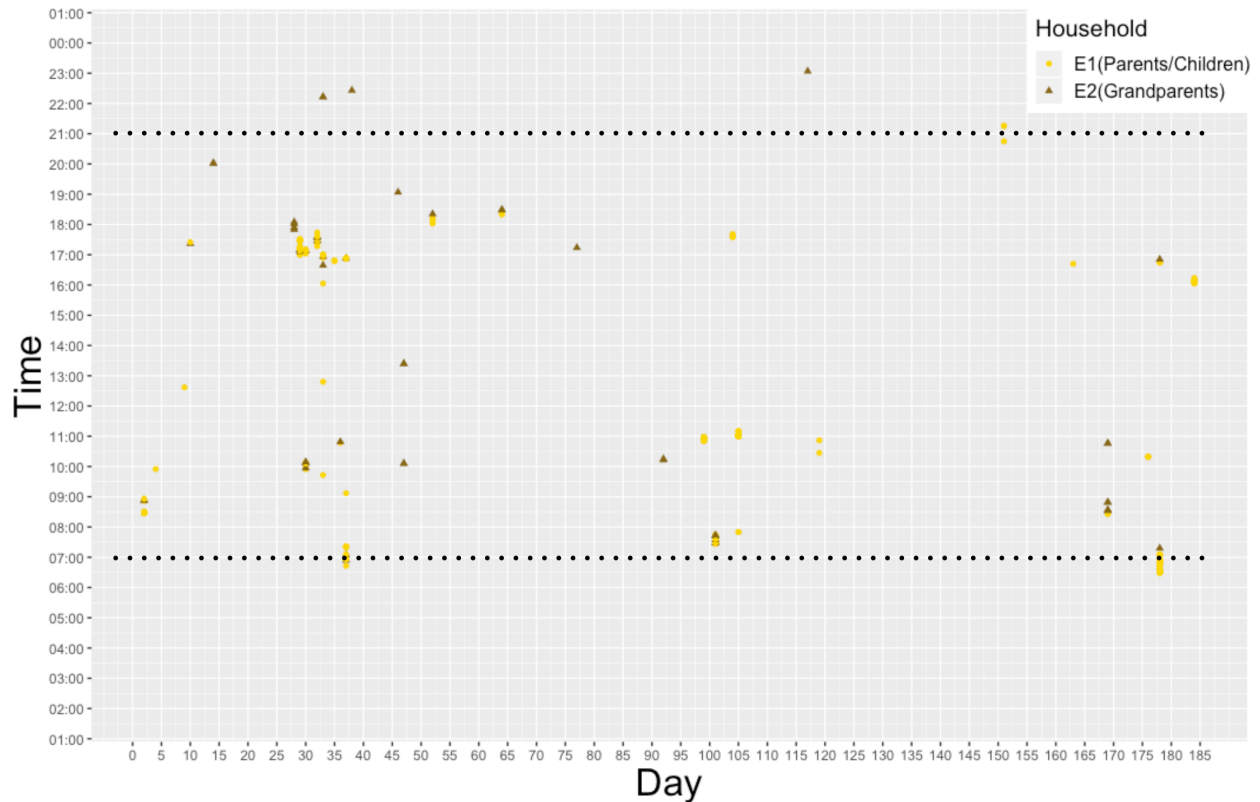
Figure 5.14: Family E did not use the system very much but there seems to the number of interactions from each house seems similar.

Theme Generation

Themes were generated in a manner similar to that employed in the earlier study. We used open-coding, followed by axial-coding using and extending the codes from the previous set of interviews.

Interviews were divided into passages that consisted either of turns at talk or sections of larger sustained communication based on topic. 518 such passages were identified, excluding greetings, closing, and technical discussions such as those concerned with setting up the WiFi.

211 codes were generated for these passages. Most of these were low-inference codes based
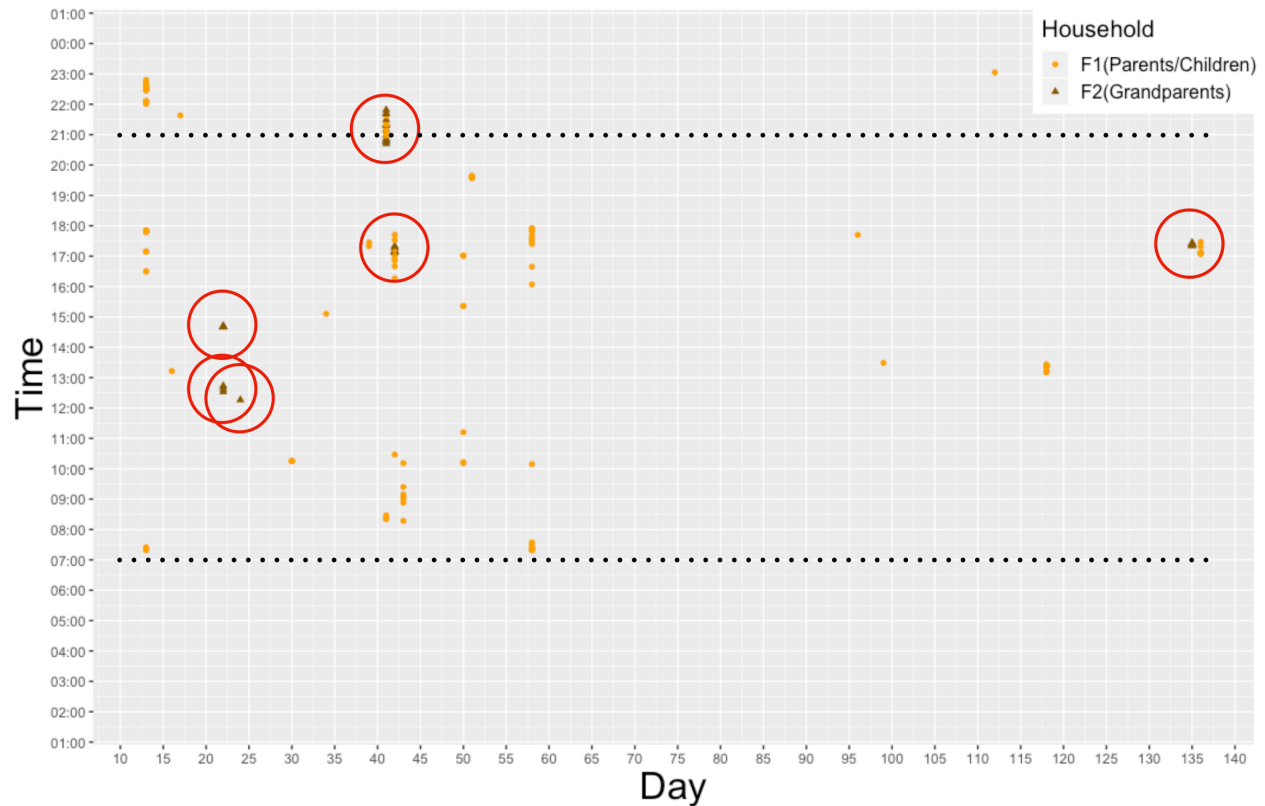
Figure 5.15: Family F did not use the system much. On interviews, we were told they much prefer to use their recently acquired whole-house music system, as they live in a three-story home. During the study period, the grandparents only used the system 6 times.

on the words that participants used, but some were higher level characterizations such as "habits".

The codes were subsequently grouped based on themes gleaned from the previous work, along with new ones described by the participants. The tree of codes is shown in Figure **??**.

The ten most frequent themes and codes were: References to specific songs or artists, connection, feature requests, technical problems, CardSong creation, playlists, habits, remote awareness, CardSong decoration, and communication. These codes were presumably most frequent because they represented on-going matters in using FamilySong. Other codes are important because they represent decisions or practices that usually continue once estab-

lished, such as the placement of the boxes.

We used these remarks associated with these codes to address three types of questions: (1) whether the current system and study replicated the kinds of phenomena we saw in the earlier study; (2) the degree to which the changes to the system promoted the anticipated experiences and behaviors; and (3) what values, experiences and behaviors emerged as important to the participants.

The following discussion does not follow this sequence because our consideration of the data starts with the reported experiences of the participants and these experiences were heavily influenced by the boxes and cards which were the user-facing elements of the system.

The following sections refer to participants by using their their position in the family (child, parent, or grandparent) and the family letter (A-F).

5.4.3 Placement of the Box

The grandfather from family E, who does woodworking and other crafting activities as a hobby, reported that he found their box aesthetically pleasing and that it provided good audio quality, thus making it easy to place it in prominent locations in their homes. Most other families were less explicit about their liking of the boxes, we received muted compliments (e.g., "it looks nice") during the installation process from five of the households, and no complaints or concerns regarding looks or form-factor.

Most families placed the boxes in accessible locations in the living room or kitchen of each home. Previously, House A1 had placed the device behind the TV, rendering it inaccessible (and out of mind) to the children. Now a different concern emerged. Parents A expressed concern over whether their children would break the box or fight over it, and so initially decided to place it under their control in their bedroom. Parents D shared this concern and

initially placed it out of reach by their children on the fireplace mantel. Grandparents C operate a shoe store and preferred to place their box in the store as that was were they spent most of their days; initially they were concerned with the competing noise from neighboring stores but the box proved loud enough to satisfy their needs.

In short, participants treated the box as something with value, but this had some unanticipated consequences. In the case of the store, the grandparents were also concerned about it getting stolen and so placed it towards the back room. We explained that we would not hold them accountable for damages or theft, and that our only concern with such problems would be in how fast we could get them a new one. Families A and D eventually relocated their box to be accessible to the children in their living room/kitchen area. In both scenarios, the relocation of the box resulted in an increase in use (according to the adults). For A this was made to coincide with the relocation of the maternal grandparents to their home in Ecuador.

Summarily, we believe we accomplished our objectives for the aesthetics of the box considering that nine out of twelve houses placed it in a prominent location in their living rooms. Three houses did not place the box in accessible locations initially but eventually relocated them.

5.5   Reported Patterns of Use

Families frequently describe listening to music around meal times and when they notice the remote household arriving home. Because most our families live one time zone away at most, practices of communicating around meal times were already quite common. Several families (A, B, D, and E) indicated that exchanging music through CardSongs has become one of the activities that they now perform in parallel to their video calls. Other explicit routines that have been adopted by some families include morning wake-up songs, bedtime songs,

and, more rarely, happy birthday songs.

At the same time, the system had both technical and social limits for some participants. Some participants have expressed concerns playing music around early morning and evening music, as they believe this might bother the remote household. Grandmother E reported listening to music on her phone throughout the day because she did not want to inadvertently play music inappropriate for the grandchildren. She only chose music to play through the system after thoroughly considering whether it was appropriate. Grandfather D pointed out that the system did not support listening to the music while away from home. He wanted a solution for his commute and work hours, while the grandmother spent some weeks at their beach house where she could not get the system configured.

5.5.1 Connection and Communication

An on-going question is concerned with characterizing what kind of system FamilySong is. As already mentioned, some participants did not want to use it except when others were also listening, but others wanted even more access to it as a general listening system across multiple situations. Consistent with reports from the prior study, one grandmother told us that listening to music alone already provides pleasant feelings.

As in the prior study, most participants referred to various components of the system as "communication". This term seemed to reflect not only feelings of connection but a kind of dialogic interaction in which they were able to send and receive messages through the day. These messages were often characterized as an "I'm thinking of you." In our recruitment interviews, most grandparents said their existing communication practices already worked well, satisfying their needs. They were not complaining.

In fact, the question of "what kind of system FamilySong is" is deeper than a simple di-

chotomy between a personal music listening system and something people enter into together at the same time. FamilySong seems to address different and significant aspects of familial interaction that are missing. It can create opportunities to *enter into* on-going behavior. As expressed by grandmother C: "Even though I communicate with them every day, when I arrive I hear songs playing already over there. It fills me with happiness and I wait for [them] to stop playing so I can play some of my songs. It's a way for us to communicate, and [my daughter] is always telling me how beautiful the songs are. It is a beautiful way to communicate. I really like to communicate this way." Her daughter, Mother C, reflexively said: "The other day she put a song that we sang when we were kids. She says that the first time she heard it she even cried. So she is very sensitive and sentimental. Yes we have liked it." Grandmother B similarly said that FamilySong "intensifies the quality of communication."

FamilySong also can broaden the purpose of communication. Grandmother D says "it's not just about having something to say, and then calling each other." Participants do not need to find a convenient excuse to make a phone call and then establish availability (i.e., "are you busy? can you talk now?").

Grandparents were quite emotional about this connection in the previous study. Their reaction replicated. However, additionally, this time, with the reduced need for parents to mediate the children's use of the system, we found parents expressing similarly positive sentiments. Songs just begin playing through the day, mother A says: "You are cooking and a song starts playing. You are chatting at the table and it starts playing. You begin to think about the setting of where the song is playing. My parents' home."

Mother A also related an emotional moment of connection between her and her mother:

> My dad played a song that we recorded together before they left. I was speaking with my husband and then the song played and I was struck with sadness. [Later

> she called her mother...] She tells me it is wonderful to wake up to the songs that
> the kids [send to her] and are playing for [her]. She became very emotional, and
> I told her that this box makes me cry. We began crying together due to your
> freaking box.

Again, replicating the prior findings, music may also constitute the start of a conversation followed through another medium. Participants indicate that they would often play a song and wait for a reply to see if the remote family was awake and available before calling them. Adults appear to take great pleasure at the children's ability to be active *speakers* in these conversations. Mother A, described these interactions as occurring within an "ecology of systems". Family E, integrated the system into some of their existing practices of sharing meals remotely.

Other conscientious behavior include specific messages created by the families. CardSongs are frequently created to send "Happy Birthday" messages. Grandfather D wanted to send a Happy Mother's day message to his daughter-in-law by finding the right song for her. Some routines through the day are described as songs are chosen for waking each other up, signaling an arrival, or going to bed.

Parents encourage their children to send songs to their grandparents, and when music plays back they attribute the event to "grandpa is thinking of you."

All participants collaboratively developed a shared knowledge of the songs that the family enjoys. Importantly, in the current study, young children are reported to have learned about and appreciated the songs their grandparents like. Regarding repetitive playback by the children, some adults like grandmother C argued that repetition provides an opportunity to learn what the child likes and that, as the child learns the lyrics and melodies, so do their grandparents. Of this type of events, grandmother D smiled and simply said "that's how

children are."

As opposed to a videocall, these musical messages can be appreciated without giving it the center of our focused attention. They are also less intrusive but not completely so. Mother C in particular expressed some frustration in the way her mother (grandmother C) used FamilySong to request music as a way to confirm she was home. She justified her mother's behavior as rooted in the heightened awareness causing anxiety when she and her son were not home and potentially in some danger. Grandmother C mentioned during the recruitment interview that "I think I bother my daughter too much." This interaction in particular points to a characteristic of their relationship that is deeper than the particular technology, and that both openly acknowledge needing to work on. That said, on an informal conversation at home, my own mother once remarked that to her use of the system *indicated* a desire to communicate. Therefore, that we should not be using it if we "wanted to hide." Last, a few households (A2, B1, B2, and D2) reported events where a local conversation with a guest was sidetracked because music started playing. On these occurrences families chose to explain what the system was and that the music was being selected by their far-away relatives. On three occasions participants indicated that their guest would be interested in purchasing a FamilySong box if possible, seeing in the system a possibility to connect with older relatives (guests of A and B) or other cousins and uncles (guests of D).

Our families have developed several use practices and habits regarding the system. Individuals get to share serendipitous exchanges with their relatives because the system is always working in the background. For some participants this has taken an aspect of control at a distance (e.g., "are you home? please get [grandchild] to choose a song for me"). However, even in these instances family members seem to find joy and yearning in the serendipitous moments of mutual awareness. Some emergent common practices within each family include: Playing a wake up song, knowing when the others have arrived because music starts

to play and initiating videocalls based on this knowledge, engaging remote family members in a *conversation* by taking turns in playing songs. Because the CardSongs are found to be accessible, children are reported to be more active than before in these interactions, bringing powerful feelings of joy to their parents and grandparents.

Lastly, and echoing a feeling that non-coincidentally we deeply agree with, my father drew a connection between FamilySong and food: "Liking food has a physical component. Liking that you taste but there is also an emotional component. You remember what your mother fed you or what you ate with your children, and when you have it again it is a special joy." He further described these practices of music (and food) as being an integral part of his family's stories, memories, and connections.

5.5.2   Interacting with CardSongs

Reaction to CardSongs can be grouped into two distinct categories: (1) creating and decorating, and (2) playing. Other codes that feature prominently in this section relate to *selecting music* (during the creation process and daily use) and mentions of specifics songs or artists.

All adults reported that, once made, they found the cards very accessible, manageable and easy to use. No family reported issues with using the cards, with even the youngest child (18 months old) being able to identify and manipulate cards for use with FamilySong.

CardSongs had competition in the ecology of listening mechanisms in the household. Surprisingly, in this population, CardSongs often solved problems compared to smart speakers with voice-assistant technology or apps on phones. Voice-assistants were less accessible for children and some adults due to requiring exact pronunciation (often exacerbated by having to specify each song's author, title, and version so there would be no confusion). Meanwhile, phone apps require skills not fully developed by children younger than 7 (e.g., reading,

writing, fine motor skills), necessitating help from an adult.

Despite problems with creating the cards and the competition, 425 cards were made, used and mostly appreciated.

Creating and Decorating CardSongs

Music selection, embodied in the CardSongs creation process and as a constant activity when choosing what to listen, was foregrounded during our interviews with the participants. Several told us that they had spent time thinking about songs they would like to add to their CardSongs, and the motivations were often referred to as related to values, memories, people, and also more plainly but not insignificantly just because they like those songs.

Parents, and especially the older children in the study reported decorating the cards, imbuing them with meaning and facilitating recognition by themselves or younger children and siblings.

Most participants described their CardSongs as created for sharing or dedicating music to another family member. While a large number of these songs are meant for the children, other significant songs were mentioned by them:

- Grandmother D blushed visibly on Skype when indicating that her husband made some cards for songs that they listened to when they began dating.

- Most grandparents created a few cards from their (now) adult children's childhood. These cards elicited strong responses from their children. Father D told us that "It was beautiful to see that link as an adult between me and my mom, and that now my son knows those songs too."

- Family A conducted two CardSong creation sessions as a whole before the grandparents

moved back to Ecuador. In these sessions, the parents assisted the creation process while the children selected and decorated the cards. Several of the cards were made to give away as parting *gifts*. During the session, the children danced to some of the songs and grandmother A told them that every time she would listen to that song she would think of them and of the dance.

- Some songs were chosen for their message-like properties. Grandfather E told us he spent some time thinking of a good song to congratulate parents E on finishing a move to a new house. Similar instances were described by other families for choosing birthday and mother's day songs.

- The grandparents from C and D also reported creating several religious CardSongs.

With regards to decorating the cards, we requested our participants to send us images of their favorite cards via text-messages or email. A first difference in motivation seems apparent between parent-child households and grandparent households. Grandparents did not draw on their cards, or at least not on the cards they chose to share with us (Figure 5.16 shows some pictures submitted by grandparent households). Meanwhile, parent-child cards were sometimes richly decorated as the pictures were the primary means of identification for the children. Figure 5.17 shows some cards decorated by the mother from family D.

Parents A reported that their children were especially excited about decorating the Card-Songs they create using the provided markers and sticker labels. Mother A, indicated initially that the children were as or more interested in decorating the cards than in actually playing them and would easily spend an hour painting them.Figure 5.18 shows three of their cards. All the parents told us that they found that even their children—the youngest two children (excluding the newborn from family D) from families C and D were 2 and 1 years old—were able to search and identify each card based on the decoration.

Mother A told us that she thought of the cards as little treasures that her family had spent time creating, decorating, sharing, and that through their use both the cards and the songs had acquired richer meaning.

However, creating CardSongs also presented problems for some parents and grandparents. The process of finding the right song (and version) to assign to a card was not sufficiently accessible as the card creation system requires precise indication of the artist's name and song title. Mother A, and grandparents B, C, and D report complex strategies for finding the right song which involve the use of Google, YouTube, Spotify to narrow down their
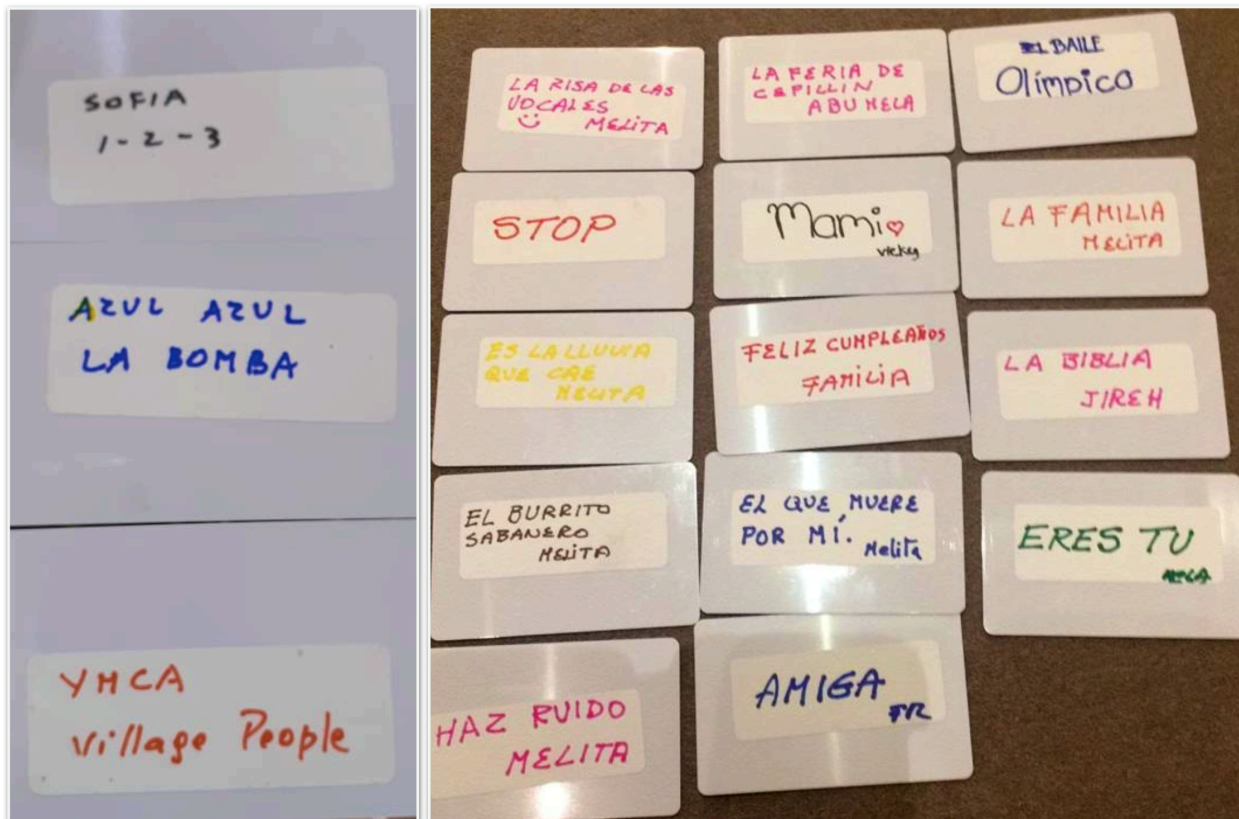
Figure 5.16: Cards decorated by grandparents from families C and D. The decorative elements are very basic, with the only perceivable ones being a color correction to write the name "azul" with blue ink, a smiley face, and a heart under the word [mommy]. These grandparents identify their cards through the written text.

Figure 5.17: Cards created by the mother from family D.

queries. Often for older songs, the participants might begin the process by talking about or singing the song with someone else. In one scenario, mother A recalls a search she performed with her father to find a song he recalled as performed by Louis Armstrong and since they could not find it resorted to choosing another version performed by Sinatra which had a different title but was the correct melody that grandfather A recalled. Mother A told us these would be frequent occurrences with her father as his musical memory is too large and is not structured around specific names and titles. Ultimately, even with a precise version identified, Spotify might not hold the rights to stream it, rendering a complex and arduous process moot.

Control of the Queue

We told the families that songs would be queued when a CardSong was used before the current song ended; however, we did not provide them with a method to visualize the queue. This influenced system use.

Sometimes it worked out well. Several participants describe how this limitation provoked games they played when sending songs back-and-forth between the homes as it provided a small element of wonder and surprise as they thought about what would come next.

Most often, and especially at the beginning, participants report using the system to send only one or a few songs at a time expecting a response from the other house. Eventually, some families began using several cards at a time, without waiting for their *turn* to finish, essentially creating ephemeral ad hoc playlists. The issue of control of this shared hidden queue began to develop as families socially negotiated appropriate behavior.

However, there were behavioral dilemmas especially around issues of interruption. Child C1 (5 years old) was described as being very possessive about the system. He would enforce his choices of music and play his preferred songs repeatedly through the day. The child frequently used the Stop card to interrupt others' songs (the child's house used the Stop card 414 times and his grandparents only used it 41 times). In general, adults struggled to decide if and when it would be appropriate to use the Stop card. Parents C told us they
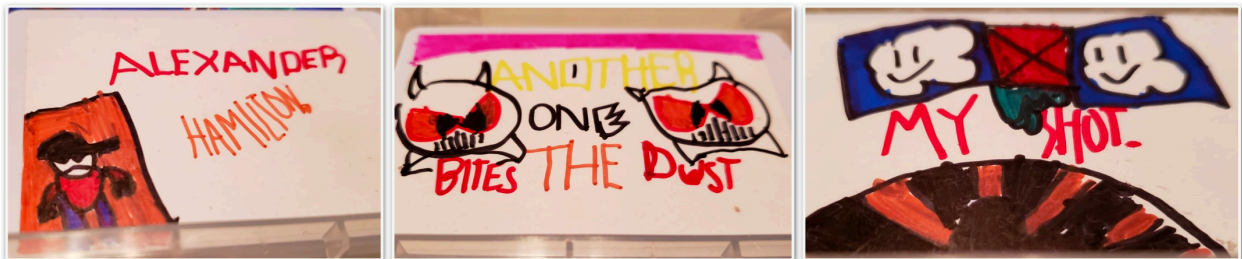
Figure 5.18: Cards richly decorated by the children from family A.

would be interested in (1) modifying the Stop card functionality, (2) altering permissions for the child to use it, or (3) introducing other special cards that would help in addressing some of their queue management issues. Father C was particularly concerned with his son's ability to stop songs selected by the grandparents. He thought that perhaps the Stop card should only be able to remove songs chosen locally, leaving the remote songs enqueued. Mother C was more interested in approaches to control the queue such as implementing a *Next* card to skip instances of repeated songs. Both of them suggested we introduce *Playlist* cards to encourage more variety and less repetition. In contrast, grandmother C laughed and commented that this was how children behave, that she was happy to learn the songs her grandson liked and that she just waited for her turn.

Parents D took a different approach by simply putting the Stop card out-of-reach in a high shelf and using it only for correcting mistakes (i.e., when a child, seemingly, has placed the same song several times in a row). They and other households (C1, C2, and E1) chose not to use Stop cards at a all concerned with being rude to the remote family members.

At the same time, the desire to listen to planned longer programs was quite important to some of the adults — some types of music are not structured around listening to single songs, like classical music where the unit is the concert. When participants wished to listen to music while performing another activity, like cooking or washing dishes (hands busy and unavailable), it was too demanding to select only a few songs at a time. Father E wanted to be able to queue up hours worth of music before beginning this type of activities. His wife however thought this type of long playlists would discourage her and her parents' habit of taking turns to send songs with the children.

Some participants like mother A and parents C suggested adding information about the state of the queue: how many songs were on the queue and what the next songs were. However, mother A reflected that showing the queue might remove an element of surprise (she called

it magic) of not knowing what music her parents had chosen to play for her until it played.

Future design work needs to explore different balances of interruption and continuity in the context of complex family dynamics.

Feature Requests

We have already mentioned that some participants felt strongly about certain changes and additions to the affordances provided by FamilySong. Families seem to be mostly interested with adding playlists, providing arguments for and against their inclusion.

With or without playlists, managing the queue was also deemed important and participants suggested features like adding Skip, Previous and Shuffle cards, and providing more information on the screen about the queue.

Family D also wanted to be able to include music that was not in the Spotify catalog as some of them have actually performed professionally and have recorded music.

The last two notable suggestions were to (1) add an option to see a history of songs played, because sometimes one might miss a song when out of the house, and to (2) according to mother A let children do more and have more control.

5.6　Discussion

In this iteration, we have been able to observe more families using a variation of the previous system over a longer period of time. Most families described patterns of use, along with perceived values and system affordances, that seem to replicate what our first attempt concluded. The system was used regularly, integrated into the habits and communication

patterns of every day life. Grandparents expressed themselves in emotional terms about the benefits of connectivity through music.

Some things appear to work acceptably well; others need more design or better solutions to accommodate varying understandings of the system.

Beyond the bare-bones of system use, we continue to note that participants express strong feelings about the sharing of meaningful experiences and knowledge between far-away homes. Achievements include that (1) participants continue to use and enjoy various key aspects of the system, that (2) young children can participate in music-selection and communication-like events, and that (3) adults report powerful feelings including admixtures of joy and melancholy. For this reason, we believe that systems in this design space interact with important, enduring themes in human life and desirable qualities in connectivity.

Ultimately, implementing any of these requests would result in a re-configuration of the system that we would like to understand better before taking action.

5.6.1 Songs versus Playlists or Communication versus The Self

Two challenges emphasize ambivalence and opportunities as they are understood and appropriated by each family that require further design and exploration: a) an apparent choice between music listening (through playlists) and communication (through turn-taking), and b) politeness dilemmas with respect to interruption mixed children learning how to take turns.

Many participants have discussed or requested that we add the possibility of assigning playlists to cards while *also* maintaining support for single-song cards. Since even the current implementation of the system affords an exploitation of the hidden queue to allow for an emergent playlist based on swiping in multiple CardSongs, participant comments are based

in exposure to some of the trade-offs involved. Although there are obvious technological limitations in this exposure, we see that their notions are heavily gated by the social practices of the group. Grandmother C framed long waits for her turn as positive, permitting her grandchild to express himself, feeling content when she eventually got to choose some songs. Yet, the mother and grandparents of family E argued that playlists would dramatically changed the dynamics of the system, fearing that one user would take over the system for long periods of time.

One prevalent view is that the system is about communication, exemplified by back-and-forth response-like interactions with songs as the messages (this is what the mother and grandparents of family E valued the most); and in this context the other is described as an individualistic enjoyment of the music with an ambient connection (a portrayal of the characteristic habits of listening to music at home by Father E). In the context of the current design, single-songs facilitate a conversational understanding of the system as participants know that when the song ends they may get to listen to their choice next. Playlists on the other hand seem to slow down the opportunity for conversation-like interaction by making turns last much longer.

One factor that might influence our future design directions is that automatically collected usage data seems to suggest that the system is used more when participants perceive that the remote household is also listening. This behavior speaks to other domestic Media Space findings about the importance of serendipitous moments of connection, communication, and mutual awareness such as in [59] where an adult woman and her mother discovered they both exercised at the same time at night when one saw the other's leg swinging into view. Particularly, continuous use of the system (which in this case means sustained periods where music is being heard) aid in the creation of the perceived shared experience [7]. If no music is being played there can be no references to it in other communication mediums either.

The inverse of this is a somewhat surprising finding that many people do not seem to think of using the system unless others are listening. The parents from A1 told us they saw no point in playing songs on the system when the paternal grandmother was in the hospital taking care of the sick relative, disregarding the potential to use the system to listen to music themselves. When family members reported being unavailable due to other responsibilities (house A1), vacations (houses D1 and D2, on separate occasions), moving (houses B1 and E1), changing ISPs (house C1) the remote home also saw a decrease in use even though the system was readily available.

One question is whether this reluctance is due to fixable issues such as difficulty creating CardSongs using Spotify, or whether it should be interpreted as reflecting an intrinsic opposition of these conceptualizations.

Two structural limitations have also emerged that add into the complexity of design in this space:

- Certain works cannot be atomized into songs. For example, although some specific movements of classical music can be appreciated, and loved, on their own (e.g., Vivaldi's Spring, or Tchaikovsky's Dance of the Sugar Plum fairy), most music in this genre was meant to be listened as a whole work with component parts. Since the digital representations of these works separate them as songs, actual appreciation of the genre is not currently supported.

- The back-and-forth with single songs is often too taxing. Longer *messages* like playlists require less frequent visits to the box but can still be meaningful for the same reasons, continuing to afford the back-and-forth.

One avenue for future work is to explore how incorporating playlist-like cards can affect the dynamics of control, power, connection, awareness, and communication, between family

members. Grandparents B suggested approaches that emulate old disc-based music formats that would not be of unlimited length (i.e., singles, forty-fives, and LPs). A participatory design approach [6, 67, 72] would be ideally suited to understand how each family considers the changes in dynamic introduced by the new feature.

5.6.2   Increasing Children's Agency

Almost all children are reported by their parents to enjoy using CardSongs to play music. Parents of younger children (at C1, D1, and E1) aided the children's efforts to identify the cards by providing simple drawings that could be recognized by the children. On the grandparents' ends, most reported knowing or believing that their grandchildren had made song selections dedicated to them, the exception again being family F.

We saw that increased opportunity for children to begin a communication often resulted in more engaged activities like text messaging, sending pictures and videos, to videocalls. Grandparents described with noteworthy joy that through these moments they were able to share in-the-moment experiences of looking at their grandchildren dancing, singing, or otherwise enjoying the music (all families but F reported these events). This finding echoes that of other researchers like [102] in which the increase of teenagers' agency was linked to a significant increase in communication with the remote parent.

Yet there are limitations and conflicts. While some children relished the power they had over the box and some adults appreciated the child's exertion of control, not all families felt the same way. Additionally, it may be that children and families "age-out" of this system. Family F, with one of the oldest children, used the system very little. Indeed, the parents reported installing several smart-speakers, creating synchronous shared music listening within their 3-story home. They preferred voice-assistant technology as their child was already proficient

in its use and this was the easiest way for them to interact.

5.7   Summary

In its current design FamilySong affords a type of connection that is reminiscent of other domestic Media Spaces in its ability to provide serendipitous connections and remote awareness. As such, it extends that design space to explore a space that does not use live audio, live video, or both, by using music. This design characteristic avoids most but not all of the privacy concerns that researchers and families have expressed in the related work. Participants additionally describe some of the system's affordances as *communication*. The explicit communicative function is centered in the trading of songs back-and-forth,but participants also note several varieties of tacit communication. Although we might refer to these events as *connection* and *awareness*, the system is also reported to merge well within the ecology of technological communication systems and practices the families already were used to. In this sense, using FamilySong can be the precursor to a videocall by signaling availability, its motivation, and the music the topic of conversation.

The current study advances our understanding of the design space and trade-offs. Problems and challenges provide impetus for further innovation.

But, despite problems, we see that, in these interactions, songs and events are merged into meanings and cherished memories by almost all participants. This is important. One of the researchers' parents reminisced, likening these experiences to their own lasting childhood memories of spending time with grandparents, listening to music and cooking over 60 years ago. He experienced those memories as making a song special and soup taste better. These are enduring family experiences and values that we believe should be further explored in this design space and the HCI community.

Chapter 6

Conclusions

The purpose of this research has been to explore and promote family connections at a distance, with a special focus on families with young, perhaps pre-verbal children and their remote grandparents. Our approach has been to introduce the sharing of music. This research and design journey presents an evolving system and examines its use with a special focus on understanding what constitutes a valuable and valued connection between loved ones.

The literature uncovered a variety of considerations at the intersection of Media Spaces, designs for intimacy and music. Additionally, we observed elements of a solution in the ongoing interactions of my daughter and her grandparents at a distance. However, even with these beginnings, designing for the complexity of multiple households with different needs, wishes and goals and people with different power in the families and across sites remained challenging. Additionally, design could not rely on users to articulate all their concerns or desires either because they were too young, or because articulating concerns could generate ill-will amongst family members. For these reasons, we needed to be in a position to adjust our approach and decisions with great attention. An autobiographical approach made the most sense in the beginning. In following these synergistic impulses we have described our efforts through this documents as consisting of three large steps.

An initial purely autobiographical observation and prototyping phase where we gathered first-hand details on what kinds of interactions generated joy—and felt fulfilling—when fa-

cilitating communications between my young daughter (around two years old at this stage) and her grandparents. Two types of emergent patterns of communication became noteworthy and heavily influenced our design goals for the eventual FamilySong project: Singing together and learning new songs in English and Spanish in videocalls, and a naming game with toys and decorations around the house.

The first observational stage was followed by several prototypes that culminated in a short study dominated by a Research-through-Design approach in which we deployed four copies of our then latest prototype into four homes in the United States and Ecuador, thus connecting two pairs of grandparents/parent-child homes. This study validated our design intuitions and exposed significant opportunities for continuing our work.

In the last step we strove to make our system available to a larger group and for a longer period of time[1]. For this new system, we focused our design efforts in increasing children's agency, reducing the need for attention from parents during operation, and creating new opportunities for sharing and meaning-making between family members.

As such, this design journey started with our novel proposition of music, played synchronously between two locations, creating an opportunity for connections very similar to that of traditional Media Spaces, without incurring (or not as heavily) in the significant penalties of diminishing privacy that other researchers have explored for decades. FamilySong was initially implemented as a pair of small devices that that would connect to each home's speaker system, with adults selecting what music to play through a web application on their phones. This allowed family members at far-away locations to participate in a shared experience with the potential to facilitate new topics of conversation (about music) and in creating a shared vocabulary of songs (to sing together). These experiences interacted with and extended

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[1]The data and analysis presented in this document pertains roughly to the first six months of usage of FamilySong by six families (33 participants) but the effort is ongoing with most families having indicated continued interest.

other mediums of communication and related habits of use. We found that grandparents in particular loved the way FamilySong created small windows of opportunity for participation in the daily lives of their children and grandchildren. Adult participants reported finding joy in using the system and indicated that the young children seemed to also find the interactions enjoyable, even relating them to their grandparents. The consensus was that children wanted to be able to do more with the system and that everyone was happy to facilitate the experiences.

The latest design reflects four years of observation and experience, by, in particular, introducing CardSongs (NFC cards) that are detected by a FamilySong device to reproduce a song. Additionally, CardSongs provided an opportunity for expression and creativity as participants were encouraged to decorate them to make them recognizable, with some of the children taking to this enthusiastically.

As a whole, our exploration through FamilySong has unearthed several significant insights into how the participating families communicate, maintain, and develop their relationships at a distance. The in-home studies exposed and built upon family dynamics and expressions of power and agency by children. The children's actions required accommodation from parents and grandparents, which most were able to provide. This accommodation was not perfect in all cases, and FamilySong fit into some families lives and experiences better than others. Yet, overall, participants reported various feelings of joy, togetherness, melancholy, kinship and sharing of culture. This indicates that FamilySong has touched on a potential for a meaningful impact into how people experience family life at a distance.

Last but not least, we have furthered our understanding of connection and communication at a distance by expanding the design space of Media Spaces, providing through FamilySong a set of artifacts that facilitate similar opportunities of serendipitous interactions and a shared sense of place that characterized the original Media Space and the various live-audio/video

propositions by many researchers. We argue that FamilySong is a domestic Media Space technology that manages to preserve its users' privacy within the family, only exposing the shared music and to some degree their presence.

In this chapter we provide an overview of the design insights we have gathered throughout our design journey with FamilySong, and how these relate to family communications and dynamics at a distance, as well as offer a reinterpretation of the design space surrounding Media Spaces to include FamilySong and other similar systems.

6.1 Revisiting Media Spaces

Emulating the successes that Media Spaces have had in office environments [7, 25, 41, 49] in domestic settings has not been easy. In the past two to three decades, with the increased availability of *free* video-calls over the internet, many researchers have looked to provide families with the same kind of serendipitous experiences and informal communications that help build relationships [3, 58, 59, 60, 66, 102]. Yet, the main concerns with introducing them at home is that they are by definition intrusive. A Media Space modifies our conception of Space and Place in ways that make some of the emergent behaviors indistinguishable from when two people occupy the same room [50, 51]. While this may be desirable in many work situations, it is not so for all work arrangements. Furthermore, while what counts as "the same place" in work environments may not suffice for feelings of intimacy in the home, and yet more elements may count as intrusive in a home environment that almost definitionally offers privacy. Our home is a sanctuary, as adults it is our own, and for many it is the only place to exercise control.

Design goals for the home and for intimate relationships are not altogether divorced from those in the Media Space workspace, but they are more nuanced. In our work, we have framed

this relationship, between the design objectives of traditional Media Spaces and technologies for the family as a design tension [94] pitting *serendipitous interactions*,*privacy*, and a need for *focused attention* against one another in a kind of changing dance of priorities.

Looking to describe and address this tension we found inspiration in Strong and Gaver's depictions of "supporting simple intimacy" [91]. Through three prototypes they described mediums with the least-amount of information being transferred (arguably one bit), which nevertheless given the right situation could convey rich meaning for significant interactions.

In designing for families we strove to incorporate some specific properties and values of Media Spaces—serendipitous interactions, mutual awareness at a distance, and the perception of a shared place—with these less demanding mediums that incidentally were better at preserving privacy.

We found happy compromises in appropriating elements of two projects, CoListen [87, 88, 90] and MissU [66], which used music as both the reason and the method of connection. The technical arrangements of our system made sure that participants knew that only music, the focus of the interactions we supported, was shared. But the sharing of music can have great significance that spills over into other interactions. Music and songs as objects have meaning and can act as carriers for memories, culture, and identity. This means that while the interaction supported by FamilySong is limited in terms of intrusion, it introduces layers of meaning that transcend a purely informational perspective. Last, music appreciation as an activity does not *require* our full attention but can also be entirely absorbing. Sharing and enjoying music together is something people do while engaged with chores, work, exercise, commute, etc[64, 81].

Conceptually, with FamilySong we looked to extend the design space that included MediaSpaces even more than done previously. We consider, for instance, Strong and Gaver's

Feather, Scent, and Shaker prototypes as straddling an edge of this design space because even though activity characterized by it is not expressed continuously, its presence (we believe) ought to be felt and cherished by the romantic partner throughout the day with sporadic events made significant in their rarity. Brereton et al's Ambient Birdhouses [10] and Messaging Kettle [9] also convey connection, and an awareness at a distance that transcend, and shared activities at expected and unexpected times.

Once again, the particulars of what constitute a system in this design space were centered around the significant values of (1) supporting serendipitous interactions, (2) enhancing awareness at a distance, and (3) extensions of space. And as we consider these three values, these systems also exclude the live-audio and live-video aspects that define what the original Media Space looked like. We note that many previous systems that *are* described as Media Spaces have already limited audio and video as a means to alter the design tension between serendipity versus privacy [8, 74, 78] or to remove one or the other altogether. Other Media Spaces also remove the always-on aspects of the connection, with interactions that begin almost like a phone call but afterwards maintain valuable affordances [93].

The focus on the three values just described, and removing emphasis on always-on live-audio and live-video, have helped us understand other systems as examples that expand this broader design space in valuable ways.

Benchmark projects have focused on providing fulfilling opportunities for technology-mediated interaction in different situation. Some systems support connection between young children and their grandparents in reading together and playing games [3, 4, 5, 82, 83]. Yarosh et al., have also applied a Media Space description for their project that connects children with distant parents in a situation of divorce or separation [102, 104]. Several works attempt to connect long-distance romantic partners [14, 46, 67, 75] including Strong and Gaver's [91].

The multiplicity of these *new* Media Spaces highlights a characteristic of good design and clever utilization of technology that we consider valuable for the field: Each of these examples tackles the issues of long-distance relationships (romantic, familial, or other) in novel and different ways *that are situated within the existing practices of the users.* The field is broadened by the multiplicity of designs and information about how they become fit-for-purpose.

One aspect that we believe makes FamilySong particularly noteworthy as a Media Space is that music can be appreciated as a background activity. People listen to music while working and doing chores. This property of music that allows it to often seamlessly move between the foreground and background of attention, begets in our system a smooth situational awareness of the connection without distraction. The constant low-effort ebb and flow of attention between songs begins to afford an aspect of communication as described by our participants, that makes long sessions of sharing possible.

Our proposal for work in this design space is to combine aspects of practice and values in order to create objects and socio-technical systems that (1) fit within the constraints and interests of the home, (2) afford serendipity, privacy, and extend space, and (3) like FamilySong's and CoListen's use of music allow users to enjoy the shared experience while not fully engaged.

Last, FamilySong re-balanced what it meant to interact with one another with opportunities for this sharing that did not exist in the families technological and social prafacefacctices.

6.2 What's at Play? What Did FamilySong Teach us About Family Connections and Dynamics

To a greater or lesser extent, FamilySong became a part of each family's communication practices. In this process children learned how to play music that they liked, and were able to understand certain communicative intentions towards and from their relatives. This in turn contributed in developing a connection medium that was enjoyable to the family.

In section 6.1 we described Media Spaces as intrusive by nature, and although music is less intrusive than always-on audio or video, the creation of the shared experience is a phenomenon that changes (by design) who we are interacting with at any point in time when using the system.

Exploring how family members interacted through FamilySong, within this through-the-day shared experience, we were able to observe what aspects of the connection reshaped the family dynamics. In order to discuss this, we will first describe certain factors intrinsic to the families and then, separately, aspects and affordances of the artifacts and system.

6.2.1 Family Factors that May Contribute to FamilySong's "Fit" to the Participants

We conceived FamilySong during design as co-existing with and depending on several factors including particulars of family circumstances, current practices, the presence of other technologies and the presence of certain aspects of infrastructure. Some aspects of the broad ecosystem we would occupy were almost inescapable within the context we were interested in probing. Most of these factors are interrelated given the circumstances but can be discussed separately:

Socio-economic Status of Families Participating families were middle class and educated. The initial group of participants, including my own family, were the families of graduate students living in the U.S. temporarily. We eventually added two families of university faculty and one who migrated to the U.S. for tech-related work but not to study. We infer that none of our participating families were faced with the dire struggles that many migrants in the U.S. and abroad deal with such as safety and relative stability. Many of our basic assumptions in the design assume its users will have the *small* luxuries of considering technology commonplace (both in the U.S. and their home countries), having broadband access, and being able to devote some free time to their children.

Frequency of Face-to-Face Encounters Families reported seeing their far-away relatives at least once a year, when either parents and children or grandparents would travel to visit for a couple of weeks. This was not only useful for the research, but formed part of ecology connecting family members.

Culturally and Ethnically Hispanic With the one exception, participant families were Hispanic migrants from Ecuador (4 families including mine), and Mexico (1 family). Hispanic culture is broadly regarded as being family-oriented. We are aware of the influence that such values have in the adaptation and use of FamilySong Grandparents particularly indicated strong interest in sharing their cultural identity with their grandchildren, who they thought would have limited exposure to their family culture while living in the United States. Additionally, grandparents in Latin America tend to play a large role in raising their grandchildren with a lot of them taking up responsibilities for daycare duties while the young parents work.

Issues and Opportunities related to Multiple Linguistic Contexts Almost all of the families had one foot in the English speaking world and another in the Spanish speak-

ing world. This had three effects. First, it created difficulty for inter-generational communication between grandparents and children growing up in America. Second, it enhanced the desires of parents and grandparents to engage in activities that would increase the children's knowledge of Spanish. Third, it afforded opportunities to use FamilySong and related technologies such as Skype to build in translation and engagement possibilities.

Technologically Adept Probably due to the recruitment methodology all participants in the study (including grandparents and within reason the young children) can be considered adept at using technology. Without exclusion, all of our adult participants knew how to use a smartphone or computer and had frequent technology-mediated communication with their remote relatives.

Other less explicit family characteristics should affect how individuals within the group would react to the system. One such aspect is *what counts as privacy or intrusion for the family*, as pointed out in a few instances throughout the period of study, FamilySong was able to draw attention to itself when the family was attending to guests—who did not expect music to randomly start playing. Even without guests, according to a few participants (including my mother) queuing music on the system is tantamount to expressing an interest in sharing where in actuality some family members might be unable to reciprocate (if they are very busy) Therefore, the right combination of individual motivations, habituation, and interest in the interaction can distraction turns into a welcome opportunity.

Many practices that were already in place contribute to FamilySong's "fit" to the families for which it worked. In particular:

Living Far Away but in the Same Timezone Constraining the participant selection to families in the east coast of the U.S. and the north-west coast of South America gen-

erated the right circumstances for a migration pattern that favored the fact that participants could be engaged in similar activities at the same time, in distant locations.

Regular Shared Events During recruitment we saw that some families had already developed habits of having breakfast or dinner together. This provides different affordances than others have described when connecting the East and West Coast of the U.S., Europe, or Asia. In the latter configurations, participants found and developed habits that may be asynchronous or otherwise of finding small coincidences like sharing a breakfast/dinner time.

Predictability of Location and Schedule Most of the families were able to predict the other sites' and people's schedules and priorities. And most spent substantial portions of most days in the sites that where FamilySong was deployed.

The users and their circumstances are not representative of the wider population in the United States or Ecuador. We believe that the separation and the desire to remain in contact with distant relatives was a significant motivation for the users. But, while in the same country, it is unlikely that grandparents would be particularly concerned about their grandchildren being *sufficiently* exposed to the local music and language. However, it is neither clear that the experiences we describe here would be universally held for all families that are in similar circumstances. We have reflected and tried to draw out implications for design for media spaces and familial connections. But at the same time, we have tried to be cautious in making broad generalizations.

6.2.2 Design Elements and Affordances of FamilySong that Contribute to the System's "Fit" to the Participants

The FamilySong system is in fact quite complex. Many decisions are made in designing a system like this. Some of them are required for operation while others represent design choices. In thinking about the experience that the my family had and other families report, we can ask how each of the parts contributes to the solution.

Using Music as a Connection The choice to use music is obviously key. Music was hypothesized and shown in this context to be a carrier for social phenomena like meaning-making, memories, and relations. Families saw in music opportunities for teaching and learning, feeling together, communicating, and expressing feelings like love and longing. Music can serve as a forum for the expression of elements of identity and culture which grandparents in particular felt they ought to instill in their grandchildren. Parents in the second study also echoed this idea.

Synchronous Mechanisms for Listening to Music Together We designed the music listening activity in FamilySong as a shared experience with the same music playing on both homes. This is different from other social media, or recommendation systems in two ways. One is that the FamilySong system conceives of music as a public, shared experience that belongs to a place. Second, sharing in other systems is confined to those aspects that resemble sending a message. FamilySong is primarily about listening to music with someone else, as if in the same room. Within this context, music selection or use may come to operate like sending a message, but that is only one kind of role it may play. This kind of higher-level interpretation develops not as technological accommodations but in the social realm.

Using Music for the Person During recruitment and deployment we emphasized that

the affordance FamilySong provided related to the music was that the music would be heard on both locations at the same time; However, an important aspect of the system is that FamilySong does *not* discourage listening for one's own entertainment, which is as a matter of fact what most children seem to be motivated to do. While adults seemed less interested in music for themselves and expressed their motivations primarily around finding the right music that a family member would appreciate, need, or *ought* to listen to in order to reflect on people, events and values they can also use it to listen alone, accommodating other users serendipitously.

Providing a Context for Focused Interaction Not only did musical listening events sometimes take on the characteristics of a conversational exchange ("This is the device where we communicate") but we also saw music being chosen to call out specific events. These included both rare events, like birthdays and other celebrations, and more common ones like "morning songs".

Respect for Privacy and Autonomy The system does not ask participants for more exposure or availability than they want or can provide.

Attention to What Young Children Can Do The CardSongs provide an interface that allows young children to manage playing the system by themselves.

Allowing Parents to Manage When They are Needed An important component of the system, introduced in the second study, is that parents can decide when they want to spend time with their children creating CardSongs instead of being required to devote attention to music selection when the child wants to play particular songs.

Faces Interface The faces interface, which is discussed more in relationship to Study 1 than Study 2, serves as an on-going reminder to the children that the the system is about connection to particular known and (presumably) beloved family members. The

children can use the faces to announce their own attentional state and examine the attentional state of others.

6.3 Romanticization of Connection, Durability and Cultural Context

Issues that arise in the interpretation of these data include interpretation of the highly emotional language used by the grandparents in both studies. The grandparents who participated in both studies are presumably highly selected, and possibly a unique and unusual group. A few months of being in a research study do not establish that this system would be used on its own for longer periods of time, when not brought back to people's attention regularly by the needs of the study.

Family connectivity can be overly romanticized. Yet we note that the romanticization is coming from the grandparents primarily and, secondarily, from the parents in this second study. While it is possible that this is merely a novelty effect, it may have significance as such—even just a few weeks of feeling more connected might be significant for families that are suffering from separation. There is a larger issue of the criteria by which systems such as this should be evaluated. Second, it is possible that this kind of system is important in certain cultural contexts.

Importantly, one argument for the inclusion of different kinds of people in the design of technology is that they embody different kinds of values and priorities. On one hand, it is a stereotype of Latin American culture that music is important and connected with strong feelings of familial connection, but it may also be that the current system ties into enduring values that are highlighted in the context that engendered this dissertation and that we

happen to be studying.

6.4   Future Prospects

Over the course of the two studies—described in chapters 4 and 5—participants have expressed their interest in possible alterations to the system that they believed would work in their homes.

Two main avenues of parallel work have opened up based on participant recollections: Analysis and implementation of feature requests, and use with other types of users.

6.4.1   Feature Requests

With the introduction of CardSongs both our attention and that of our participants was focused particularly around issues of control of the system. In section 5.5.2 we summarize the requested new features participants were most interested in: Support for playlists, control of the queue, access to music not in the Spotify catalog. Based on the contrasting opinions of the different families, with disagreement even within a family, implementing any of these changes will likely generate a significant reconfiguration of the socio-technical system.

One branch of opportunities for continued scholarship in this design space of designing for families would be to analyze these feature requests through Participatory Design [71] activities with each family. Most likely, this would result in a few diverging FamilySong systems situated around developed practices and habits of each group. Despite any technical complications, this process would most reflect our design philosophy of a system that *fits the family* and not the other way around.

6.4.2   Different User Groups

First of all, we are interested in continuing study with the current families, whose children will continue to grow permitting us to address very long-term questions. We believe that the motivations for use might change slightly as the children develop more individualistic traits.

Towards the end of section 5.5.1 we note that some families had been side-tracked from having a conversation with a visit because music had started to play, seemingly at random from the perspective of the guest.

After explaining what the system did, some guests expressed interest in acquiring a box citing a perceived opportunity to connect with (a) far-away aging relatives, (b) siblings, cousins, etc, and (c) romantic partners. Particularly with connecting aging relatives, we might see a connection with a similar group of participants than some of the older grandparents in our studies, and yet the main motivation for communication would be very different without the children as a focus for attention. It would also be interesting to see how FamilySong works for connecting romantic partners as there is a large breadth of systems in that particular design space, allowing us to draw more comparisons.

There are several other groups of people on significantly more fraught scenarios of forced migration and refugees. A configuration of FamilySong might offer elements of connection with loved ones and cultural identity that could prove comforting in their journeys.

6.4.3   Limitations

First, none of our participating family groups expressed concerns about cultural or generational clash as foregrounded in their interactions, although we believe it is possible they may not have wanted to speak about it more openly.

Second, some adult participants remarked that their personal devices were better options for personal music consumption, as they did not need to worry about what the other household would think about particular selections. This might implicate concerns for the cultural or generational clash in the previous paragraph but there is no evidence for this claim. Generally, this indicates that the affordance for sharing might be well foregrounded in the ecology and the minds of the adults, with other devices and services that suit their individual and private needs. On the other hand, it is possible that supporting personal consumption might be beneficial to the overall experience. This was after all the reason we abandoned some of the most ambitious features in the first prototypes of FamilySong, which would have the system play music *only* when both households had people in them.

In concordance to our early proposition for a Participatory Design approach for addressing new feature requests, exploring these limitations could be another avenue of research to understand what motivates each group of users.

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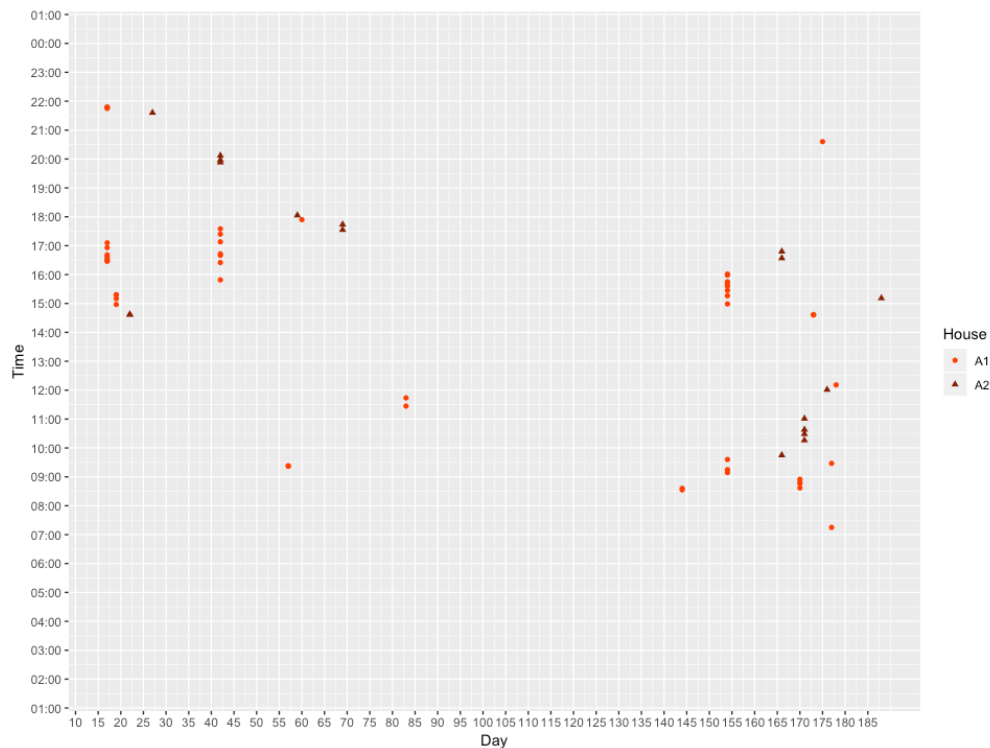
Appendices

Appendix A

Appendix: System Usage

A.1   Card Creation Over Time

These graphs show CardSong creations over time. As on the previous section, circles and triangles represent a card being created at the parent-child home or the grandparent home, respectively. A quick visual inspection tells us that CardSongs are not being created daily.
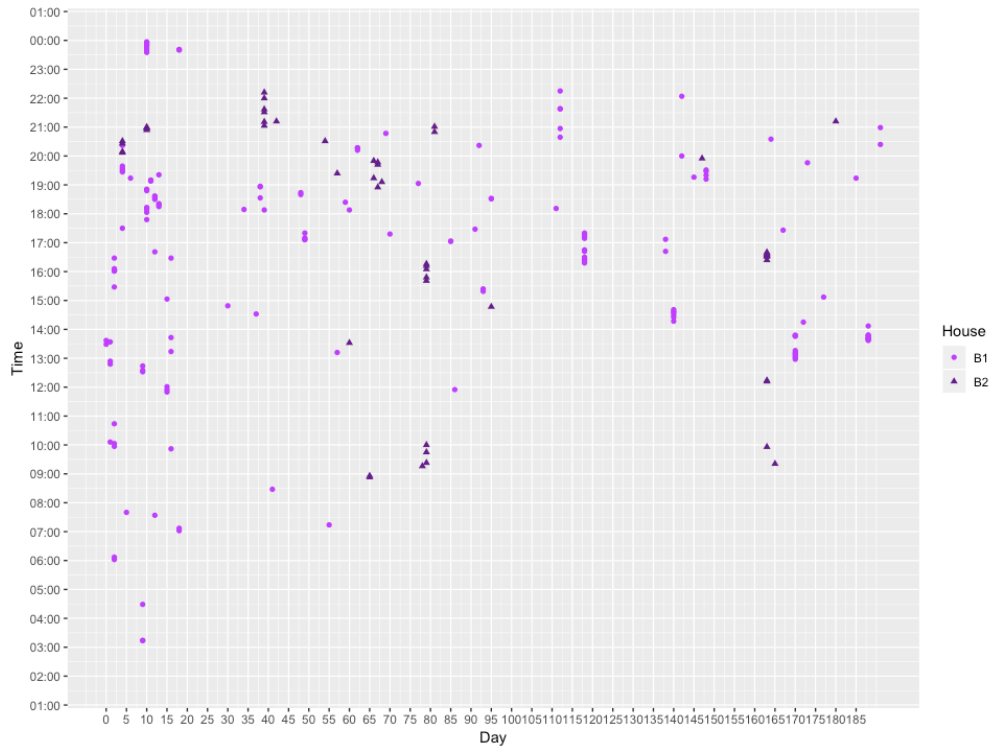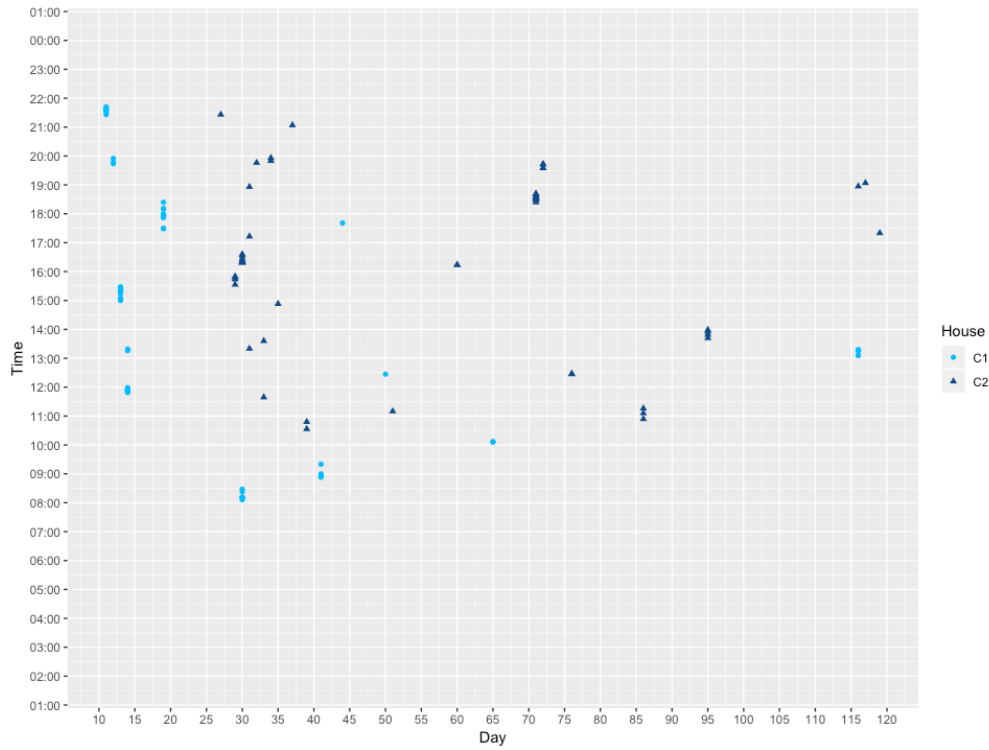

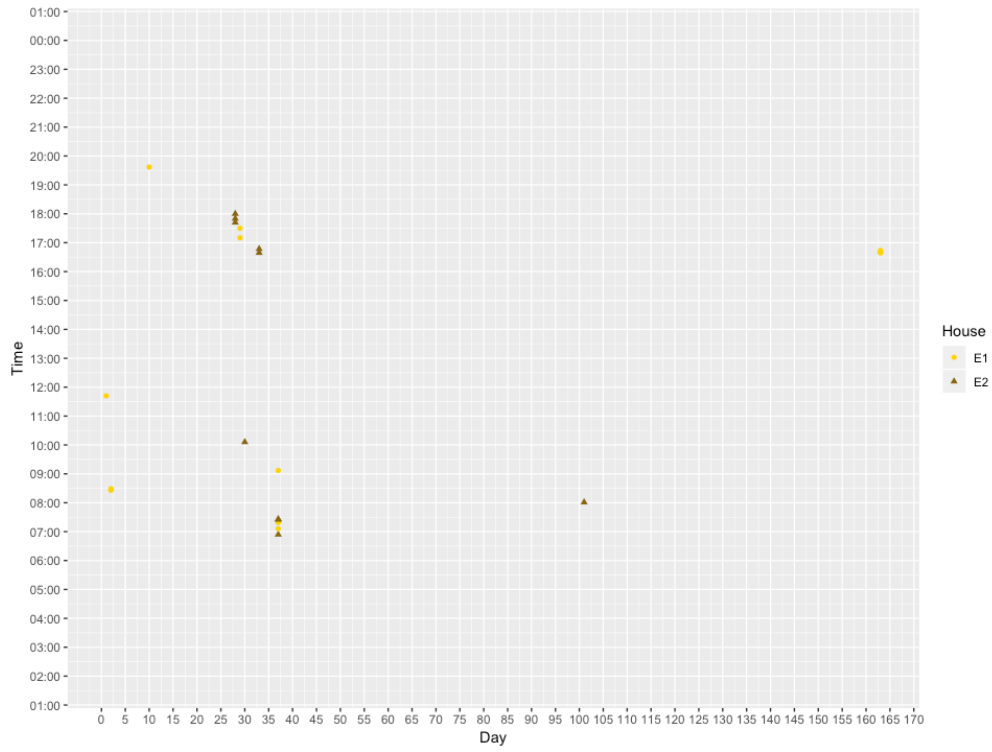Figure A.1: Family A
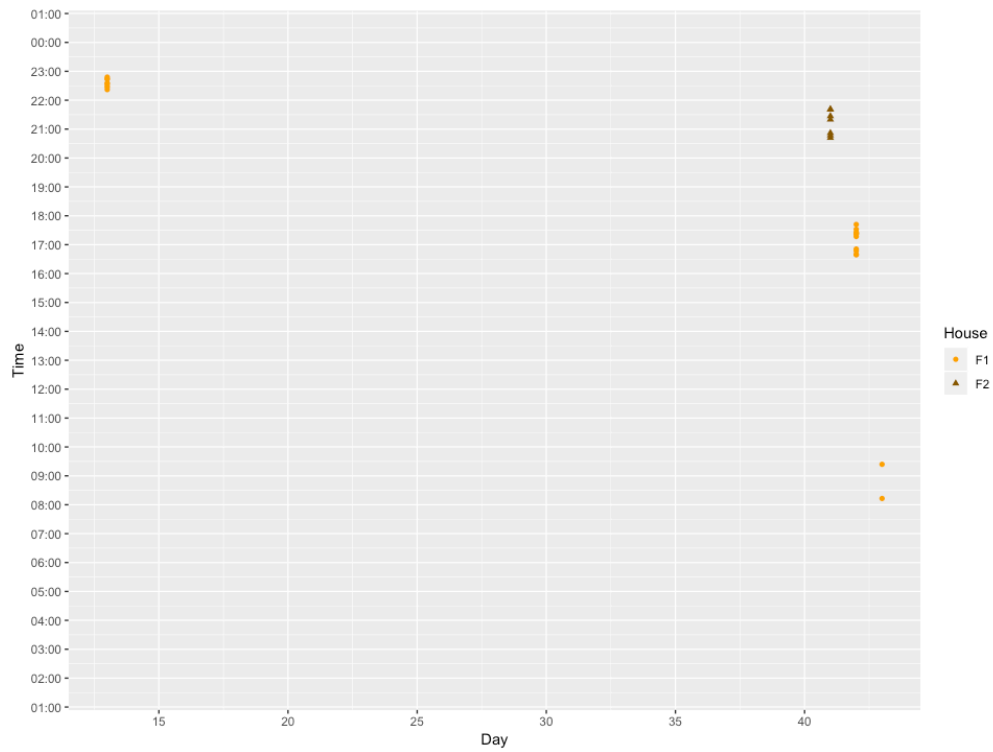
Figure A.2: Family B

Figure A.3: Family C

Figure A.4: Family D

Figure A.5: Family E

Figure A.6: Family A