Data Analysis on a Domestic Media Space Connecting Internationally Distributed Families

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ABSTRACT

Families separated by distance face the challenge of limited bonding, affecting their opportunities to connect and sustain their relationships. FamilySong is a domestic Media Space that fosters feelings of togetherness via synchronized music-listening. FamilySong was used in an experiment that ran for six months, with six distributed families. Detailed data collection, e.g. interaction routines and music sharing patterns, was gathered through the system. These data provide interesting insights into the social behavior of families separated by distance and how they connect over those distances. In this work, we built software to analyze the experiment's data. The procedures and insights described in this paper will be useful for other researchers and practitioners involved in Information and Communications Technologies projects, making the FamilySong analysis with this software an exemplar for efficient data analysis.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

ICTD, online networked experiments, music, sociality

ACM Reference Format:
Vanessa Cedeno-Mieles, Javier Tibau, Chris J. Kuhlman, Deborah Tatar, and Steve Harrison. 2020. Data Analysis on a Domestic Media Space Connecting Internationally Distributed Families. In *Information and Communication Technologies and Development (ICTD '20), June 17–20, 2020, Guayaquil, Ecuador*. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3392561.3397584

1 INTRODUCTION

1.1 Background and Motivation

Families separated by distance face the challenge of maintaining and developing their connections. Although several devices and services like videocalls [13, 14] allow family members to communicate, with very young children it is difficult to sustain moments of bonding [1, 16]. FamilySong [22] is a system on which families can connect through shared synchronous music between multiple remotely located homes in similar time zones. In FamilySong the shared-synchronous music (1) is important and enjoyable for all family members, (2) provides a context for the participation of young children, and (3) grounds other inter-generational interaction occurring through the existing ecology of communication devices and practices (i.e., pre-existing videocall practices).

In [21], the researchers recruited six families with: i) parents with young children (under 7 years old) living in the U.S., and ii) grandparents living in Ecuador, Mexico, and the United States.

One FamilySong box is located in the house with parents/children, and a second box is located in the grandparents house. Music selection is performed through the use of Near-Field Communication (NFC) cards, recognized by an NFC reader on the box. Cards are associated to song through a web application available to all adult family members. A set of 40 NFC cards and 20 NFC stickers was provided with each box. Once a card has been programmed with a song, placing or swiping the card over the box adds its song to the family's music queue, to play simultaneously on both houses. See Figure 1 for a picture of a box and cards.

Figure 1: This FamilySong box is located in a grandparent house. A second box is located in the house of their children/grandchildren. Their Near-Field Communication (NFC) cards, are stacked next to the box and are recognized by an NFC reader on top of the box. Cards are associated to song through a web application. Once a card has been programmed with a song, placing or swiping the card over the box adds its song to the family's music queue, to play simultaneously on both houses. Additionally, participants decorate their cards to aid recognition and to personalize them.

Optionally, users can create a *stop* card which stops music from playing immediately and clears the music queue. Cards can be

ICTD '20, June 17–20, 2020, Guayaquil, Ecuador

ACM ISBN 978-1-4503-8762-0/20/06.
https://doi.org/10.1145/3392561.3397584

updated any number of times, in order to associate them with new songs. Through the six month experiment these simple interactions produced a large repository of data with music selections, card creations and updates, emergent playlists, play times, and more.

Creating a sense of community among a collection of remotely located individuals is a recurrent theme in research. In [15], a voice-based community media platform in rural India that works through mobile phones is described. Reference [17] explores how development-related, voice-based, information services can organically spread among low-literate masses in the developing world. In this work, we take a novel approach in attempting to build a sense of community through the sharing of song.

In order to analyze the data collected from these specific experiments, considerable work is required to perform data analytics and computational modeling and simulations. The 'easier' method is to develop tailor-made custom programs and analytical scripts relevant to the experiment. Usually this procedure takes time, producing inefficiencies and duplication of effort. The software in [4] is generic and designed to focus on a networked temporal social science experimental modeling cycle: (i) propose/modify hypothesis; (ii) carry out experiments; (iii) analyze to confirm/falsify a hypothesis; (iv) build models from the data; and (v) exercise the models. The approach in [4] is specific to experiments among humans or other subjects whose temporal interactions can be represented as taking place on a network. We think the experiment with FamilySong can be analyzed which such a cycle, because the participant families communicate via an interactive network and carry out the needed tasks over a period of time via interactions with neighbors, exchanging appropriate information as specified by the experiment.

1.2 Contributions

1. Development of software implementations for the FamilySong experiment data (Section 3). We built codes to analyze the FamilySong experiment raw data.

2. Insights on the FamilySong experiment (Section 4). We present novel experimental data that illustrate how families interact with FamilySong to feel connection between family members. We focus on experimental data that are useful for future modeling.

2 RELATED WORK

2.1 Devices to Maintain Connections

Individuals in relationships separated by distance are eager to try different technologies to create a feeling of connection. [8] provides a review of 143 published artifacts that mediate, and create a feeling of relatedness when being separated. In [10] Family Portals provide shared video between three locations and was deployed within the homes of six families; results show that it increased feelings of connectedness and the focus on a triad, in contrast to a dyad, caused new styles of interaction to emerge. In [11] Family Window was deployed within the homes of two families for eight months and four families for five weeks; results show that always-on video can lead to an increase in feelings of connectedness by providing availability awareness and opportunities for sharing everyday life, however usage and value of such media spaces hinges on close-knit relationships and control over one's autonomy. [22] designs a system called FamilySong, a domestic Media Space with no live audio or video where families separated by migration share synchronous-music, fostering feelings of togetherness and mutual belonging. In the initial FamilySong study, grandparents particularly expressed the importance of the values and opportunities they saw embedded in the system.

2.2 Networked Social Experiments

Online networked social experiments are increasingly used to study social behaviors and explore phenomena such as collective identity [6, 18], coordination [20], and diffusion and contagion [5, 6, 12].

2.3 Systems for Social Network Experiments Analyses

Most workflows in the social sciences are for social network analyses [7]. [4] addresses social sciences for modeling/experiments; the following works demonstrate the usefulness of this particular system [2, 3, 18]. In [3, 18] novel experimental insights into collective identity are presented using the software in an online group anagram game; collective identity is produced in a group of human subjects using an iterative abduction framework. Agent Based Models (ABM) of anagrams and collective identity are developed. The work in [18] is one of the first demonstrations of abductive looping to test (social) theories. In [2], the software is used to present an exemplar of a detailed procedure for combining mechanistic and data-driven models to form single models of human decision-making that output human actions in a game.

Media Spaces like [10, 11, 22] set up the conditions under which places may be created to foster shared experiences between participants. We want to be able to uncover interesting insights and to generate/refute hypotheses about social behaviors through a Media Space with families separated by distance. In this work, to explore the data generated from the experiment with FamilySong [22], we use the automated and extensible software system for evaluating social phenomena described in [4]. Compared to other similar tools to analyze this type of data [9, 19], [4] takes the semantics of social experiments into account and largely focus on providing a generic data schema.

3 FAMILYSONG EXPERIMENT

Families configuration: Six families, looking for a new way to connect at a distance, were recruited to use FamilySong. The families had a similar configuration of two households with grandparents in Ecuador, Mexico, or the U.S. and parents and children in the U.S. A box is located on the grandparent's household and another one on the parents and children household.

Creating cards: Each household received 40 blank NFC cards and 20 NFC stickers where members of the family can associate a card with a song. For this, the user has to place the card on top of the box and use a web application to select the new song to associate with that particular card. The *stop* action can be incorporated in a specific card. If a *stop* card is located on top of the box anytime, this action will turn off the music that is playing and stop queued songs, if any.

Updating cards: An individual can replace a song already associated with a card. For this, the user has to locate the card on top of the box, access the system application and select the new song to associate with that particular card.

Interactions: The system identifies when a card from a specific household is being placed on the box which plays the song associated with that card for the family, at both locations. Information is recorded regarding when the card when is played or updated i.e. time, song and household.

Data Model: To use the software in [4], we represent this experiment with the abstract mathematical data model. This is one of the steps from to progress from a mathematical data model to a software model. Each experiment, *exp_id*, consists of one phase $n_p = 1$, with $G(V', E')$. There are $n = 2$ households for each family unit. The set of households is $v_i \in V$, where $1 \leq i \leq n$. The meaning of an edge is λ = communication channel between pairs of subjects. B_i^v contains initial conditions for the experiments. The set of actions is $A = \{a_1, a_2, a_3, a_4\}$, where a_1 is create a card, a_2 is play a card, a_3 is update a card, a_4 is the use of the *stop* card. Figure 2 shows a partial representation of the data model for the FamilySong experiment.

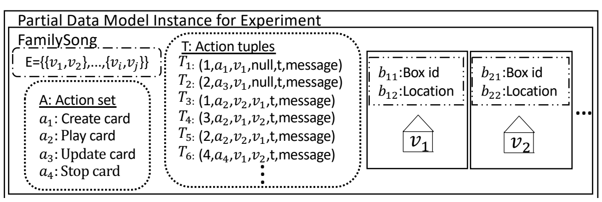

Figure 2: Partial representation of the data model for the FamilySong experiment composed of one phase with a set of V households ($n = |V|$). Edges E are communication channels between the parent-children and grandparent households. B_i^v contains initial conditions for the experiments, e.g. box id and location. The action set A and illustrative action tuples Ti are given. $T = (\sigma_i, a_j, v_k, v_\ell, t_o, py_q)$, where σ_i is a string that is a unique identifier for an action sequence, action $a_j \in A$ is initiated by node $v_k \in V'$, and v_ℓ is the target node of the action, with edge $e = \{v_k, v_l\} \in E'$, t_o is the time of the action, and py_q is the payload represented as a JSON schema.

4 DATA ANALYSIS

Our analysis software is written in Python. The experimental data transformation is executed to conform the raw data to the software formal model. Figure 2 shows a partial representation of the data model for the FamilySong experiment.

To analyze the data from the experiment, we developed different functions. Figure 3 shows a histogram of the number of cards created by user, which corresponds to action a_1. The x-axis shows the household id, e.g. household A represent an experiment with two families, where A1 is the parent-children's household and A2 is the grandparent's household. The y-axis shows the number of card created by each household. We can analyze the proportion of cards created by parents/children vs. grandfathers. Some households create more card than others, but it seems everyone wants to create cards and share. If we would like to focus on House A, we see that the father/children household creates 47 cards vs. 6 cards created in the grandfather's household. If we are curious about the action of playing these cards, another function generates a visualization of users interactions based on the available actions.

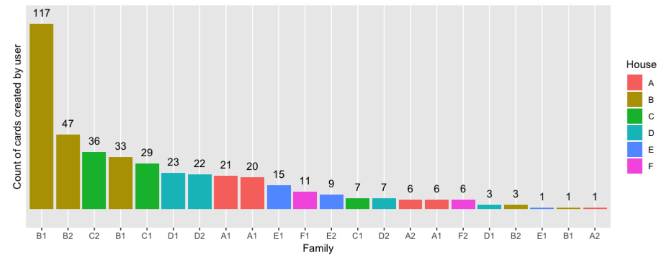

Figure 3: The x-axis shows the household id and the y-axis is the number of cards created by household. Each of the households A, B, C, D, E, F represents an experiments with two families, for example for household A, A1 is the parent-children's household and A2 is the grandparent's household. Because the creation of a card (action a_1) needs access to a personal system we can record the person in the household creating the card, this is why a household id can appear more than once in the x-axis. Self-disclaimer: Family B is one of the researchers' family.

Figure 4 shows a time series plot representing the action a_1 of creating a card in household A. The x-axis shows the days in the six

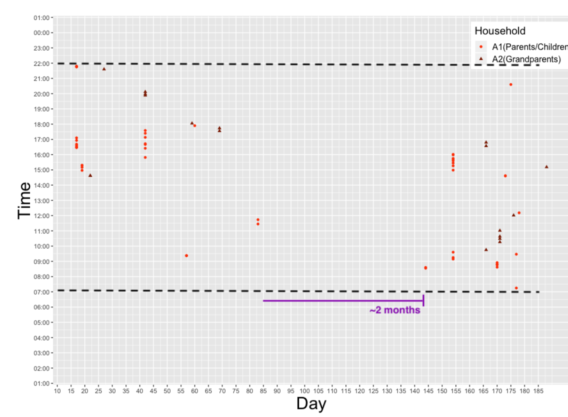

Figure 4: Time series plot representing the action of creating a card in household A. Parents/children (A1) represent the circles and grandparents (A2) the triangles. The x-axis shows the days in the six month experiment and the y-axis shows the times in a 24 hour day. The plot dotted lines shows that the hours on which the family usually creates card are between 7:00 AM and 22:00 PM. Also, the purple line shows a range of time (approximately two months) where no cards were created.

month experiment and the y-axis shows the times in a 24 hour day. Parents represent the circles and grandparents the triangles. The plot dotted lines shows that the hours on which the family usually creates card are between 7:00 AM and 22:00 PM. Also, the purple line shows a range of time where no cards were created. This raises questions of why this behavior occurred.

Figure 5 shows a time series plot representing the action a_2 of playing a card in household A. The x-axis shows the days in the six month experiment and the y-axis shows the times in a 24 hour day. Parents represent the circles and grandparents the triangles. The plot shows an increase in the use of the FamilySong system for both houses after the first five months. After conducting interviews with the families, we found out that home A1 (parents and children) was connected at first with the paternal grandfathers; but 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 the maternal grandfathers increasing notably the use of FamilySong. The purple circles indicate the sporadic use of the system compared to the increase in use after the five months.

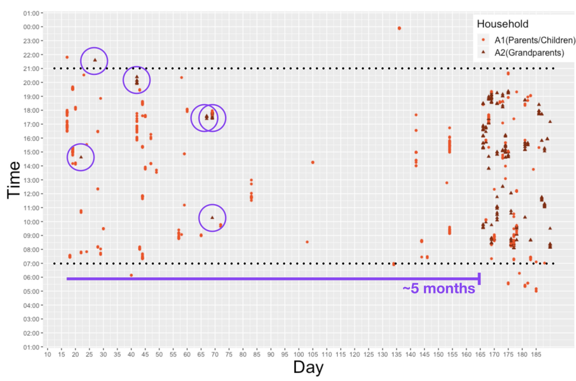

Figure 5: Time series plot representing the action of playing a song in household A. Parents/children (A1) represent the circles and grandparents (A2) the triangles. The x-axis shows the days in the six month experiment and the y-axis shows the times in a 24 hour day. Home A1 (parents and children) was connected at first with the paternal grandfathers; but 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 the maternal grandfathers increasing notably the use of FamilySong. The purple circles indicate the sporadic use of the system compared to the increase in use after the five months.

Figure 6 shows a time series plot representing the action a_2 of playing a card in household D. The x-axis shows the days in the six month experiment and the y-axis shows the times in a 24 hour day. The plot shows a decrease of interactions for a month during days 145 and 180. During an interview the grandmother reported she was on vacation visiting one of her sons for over a month. During this period of time where we see only two song selections from D2 which must come from the grandfather who reportedly stayed at home. This implies the use of the system in the grandfather's house is incentivized by the grandmother.

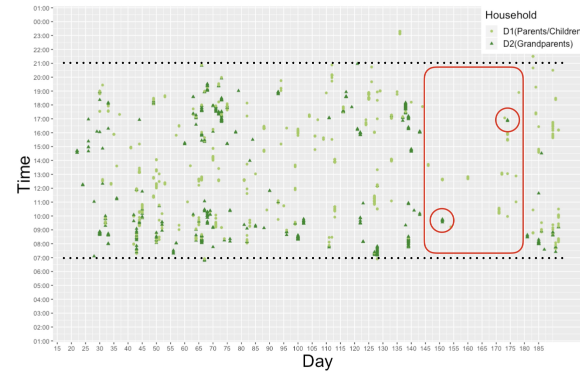

Figure 6: Time series plot representing the action of playing a song in household D. Parents/children (D1) represent the circles and grandparents (D2) the triangles. The x-axis shows the days in the six month experiment and the y-axis shows the times in a 24 hour day. Family D's interactions halted between days 145 and 180, when the grandmother reported she was on vacation visiting one of her sons for over a month. The red annotations show this period of time where we see only two song selections from D2 which must come from the grandfather who reportedly stayed at home.

5 FUTURE WORK

We plan to continue doing pattern analysis and perform mixed methods, e.g. qualitative analysis with interviews to attempt to correlate the data with the participants observations. Is difficult to deploy a FamilySong type of experiment because resources include money for technological devices, time to coordinate families participation, as well as installation, training and troubleshooting of devices at a distance. A model and simulation of the experiment will benefit this research because different configurations of the experiment can be run faster and more economically, and over a greater range of conditions. The FamilySong system does not allow the box to identify the person that is playing a card, limiting the modeling of a particular individual in a family. For now, only behavior of a family as a whole can be modeled for running simulations of different configurations of families. For example instead of connecting two homes, we can simulate the impact of interaction between three households. Also, we are curious to know how increasing family members in a household can impact usage and interactions. However, more experiments, particularly with different configurations of families would be useful to refine any future data-driven model.

6 CONCLUSIONS

We use software designed to analyze social science experiments. We use raw data from an internationally distributed experiment with FamilySong. We provide potential for novel experimental insights into families interaction with a shared-synchronous music system to enable shared feelings of connection.

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