Exploring Embodied Approaches for Large Age Gap Sibling Communication through Technology Probes

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ABSTRACT

Large age differences and geographic distance between siblings can often hinder the development of close relationships, as they may have different social circles and schedules. Younger siblings may also have limited access to digital technology, which can further complicate communication and interaction between them. In this paper, we developed two technology probes, Haptic Bubble and Emoji Board. Both of these systems utilize embodied interaction, which has been shown to be an effective way to engage children in remote communication. Our work focused on three main goals through the development and preliminary study: the system design goal involved testing the feasibility of the embodied design approach, the empirical goal was to collect information on how siblings use embodied communication technology and the design goal was to inspire new kinds of technology to support large gap siblings' needs.

CCS CONCEPTS

• **Human-centered computing → Haptic devices**.

KEYWORDS

siblings, children, embodied interaction, distributed family, remote communication

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1 INTRODUCTION

Communication technologies between family members that are geographically separated is a widely studied topic [4, 8, 23]. However, there has been relatively little research on designing technology for sibling communication [9, 15], particularly among siblings with a significant age difference. In comparison to other relationships, sibling relationships are unique in that they are typically the longest-lasting family relationships, characterized by a blend of both intense emotional bonds and competitive or adversarial interactions [10, 21].

Sibling solidarity develops from sharing common experiences and is one of the biggest predictors of sibling communication satisfaction [17]. In other words, stronger relationships (called loving) are characterized by informality [17]. Additionally, consistent communication led to greater sibling liking and loving [17]. However, siblings tend to contact each other less when they don't live physically together [13]. This physical distance can even lead to emotional distance, making siblings feel that their relationship before was closer [13]. This physical separation occurs for siblings with a large age difference more frequently given the number of life changes that occur, like older siblings leaving the parental home for higher education or as they join the workforce. The shift has resulted in a large number of separated families having one elder child remote and one younger child in the home. Maintaining a close relationship with both a large age gap (e.g., five or more years) and a large physical distance can be more challenging caused of differing social circumstances and psychological development.

A previous study [15] provided evidence showing the need to design solutions for large-age gap siblings connection. Building on this, our paper explores embodied approaches to support remote communication between large age gap siblings by focusing on interfaces that children are already familiar with and augmenting them with additional functionality. Embodied interaction has been shown to be an effective way to engage children in remote communication [22]. Therefore, we proposed two technology probes in this study which is driven by the following research questions:

- (RQ1): Is using embodied approach for designing communication technology for large-age gap and long distance siblings feasible?
- (RQ2): What are the ways in which siblings use technology in an embodied way?
- (RQ3): What are new kinds of embodied technology to support large age gap siblings' needs?

2 BACKGROUND AND RELATED WORK

2.1 Sibling Dynamics and Design Considerations

Sibling relationships greatly differ from parent-child or spousal relationships and require different design considerations. Although remote communication between siblings is not the protagonist of many HCI studies, it exists in many kinds of extended families studies in an indirect way, for example, left-behind families [4]

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and divorced families [23]. While siblings can benefit from technologies designed for distributed family communication, there are unique subtleties presented in this relationship that need to be acknowledged in the design of communication technologies for remote large age gap siblings. Our prior work [15] revealed the unique needs and considerations faced by stakeholders involved in remote communication between large age gap siblings in a non-western context. Specifically, prior evidence has shown that the communication between siblings was generally lightweight. There were design implications in promoting child-led conversations under asymmetric relationship expectations. For example, technology should minimize the negative impact of digital overuse to address parents' concerns, and scaffold child-led conversation to reduce rivalry and improve engagement. Therefore, our study is rooted in these considerations and uses an embodied approach that incorporates physical elements for younger siblings to better support child-led conversation.

2.2 Technologies for Distributed Family Communication

Technologies designed for distributed family communication can provide benefits for siblings as well. Common synchronous remote communication usually includes phone calls or video chats. Video calls are typically more engaging to children than traditional voice-only phone calls [2] but often require additional assistance for camera and technology set-up [8]. Configurations like in the Family Portals [16] and Painting portals [19] eliminate the "set-up" work associated with prepping for virtual communication by using cameras that are always on. Immersive environments have also been used to empower remote communication, like projecting table surfaces using Augmented Reality, which allowed children to playact with toys with their remote families [23].

Despite the enduring importance and long-lasting nature of sibling relationships, few studies have explicitly examined how technology may impact them [6, 21]. One notable exception is a study by Go et al. [9], which examined gaming patterns among siblings who played together in the same location. The study identified challenges in promoting sibling engagement, such as age differences and skill disparities that made it difficult to play the same games. Unlike this prior work, the aim of our study is to design technologies for remote siblings who have a significant age gap through an embodied approach.

2.3 Embodied Interaction for Mediated Communication of Children

Embodied communication refers to the use of technology to convey physical and emotional experiences between remote individuals. Unlike traditional forms of remote communication, such as phone or video calls, embodied communication aims to create a sense of presence and physical co-presence between users[5, 7]. For children, embodied communication can be especially important, as they rely on physical touch, gestures, and nonverbal cues to build social connections and emotional bonds with others. Children also have unique developmental needs, such as the need for physical play and exploration, which can be difficult to replicate through traditional forms of remote communication [23].

In recent years, researchers and designers have explored various forms of embodied remote communication for children. There are many examples designed for children including haptic feedback devices (e.g. PlayPals [3] and Always with me [12]), and robotic avatars (e.g. Robotic stuffed animals [18]). The most relevant examples to this work are Mole Messengers, are pushable interfaces that provide a way for family members, specifically children, to communicate in an interactive way through asynchronous play[20].

Taking inspiration from previously developed embodied tools, we designed two technology probes: the **Haptic Bubble** and **Emoji Board**. Both of these systems include a physical component for the younger siblings and a corresponding virtual part for the older siblings, developed with respect to the asymmetry in technology comfort between the siblings.

3 FORMATIVE INTERVIEWS

To ensure that similar considerations of our prior work [15] existed within a western context, we conducted formative, semi-structured interviews with 3 families. The sibling pairs were recruited from personal connection, with the age gap of 16 (28F,12M), 11 (21F,10M), and 7 (20F,13F) and all were geographically separated for at least one year. The interviews took about 30-45 minutes. We interviewed older siblings regarding their sibling relationships and remote communication experiences, challenges of communication. We also introduced and asked questions about the implications which emerged from the prior study, such as how they felt about a child-led conversation. We didn't specifically interview the younger siblings but we asked older siblings to collect insights from their younger siblings to see if the implications still held. Following these studies, we performed a data-driven thematic analysis. The transcripts of responses were open-coded and then affinity-mapped.

Our results showed that in non-western contexts, older siblings often act as primary caregivers, whereas in western contexts, older siblings typically take on the role of a tutor. Although there are slight variations in their roles in the western context, all of the conversations testified to the desire for a child-led interaction to fit the asymmetric relationship of varying timetables for both siblings and lack of personal technology access for younger siblings.

4 TECHNOLOGY PROBES DESIGN AND IMPLEMENTATION

Technology probes are seen as a tool that is used to "find out about the unknown, to hopefully return with useful or interesting data"[11]. The purpose of using a probe is to inspire design in the early stage. Therefore, the goals of our study are (which followed work [11]): **System-building goal**: testing the feasibility of the embodied approach for siblings. **Empirical goal**: collecting information about how siblings use technology in an embodied way. **Design goal**: inspire siblings and researchers to think of new kinds of technology to support large age gap siblings' needs and desires.

In this study, we opted for an embodied design approach for the younger siblings to engage with, while simultaneously developing a web application for the older siblings, providing them with greater flexibility in terms of time and location. Based on the results of the formative study, we designed two tech probes in order to achieve these goals.

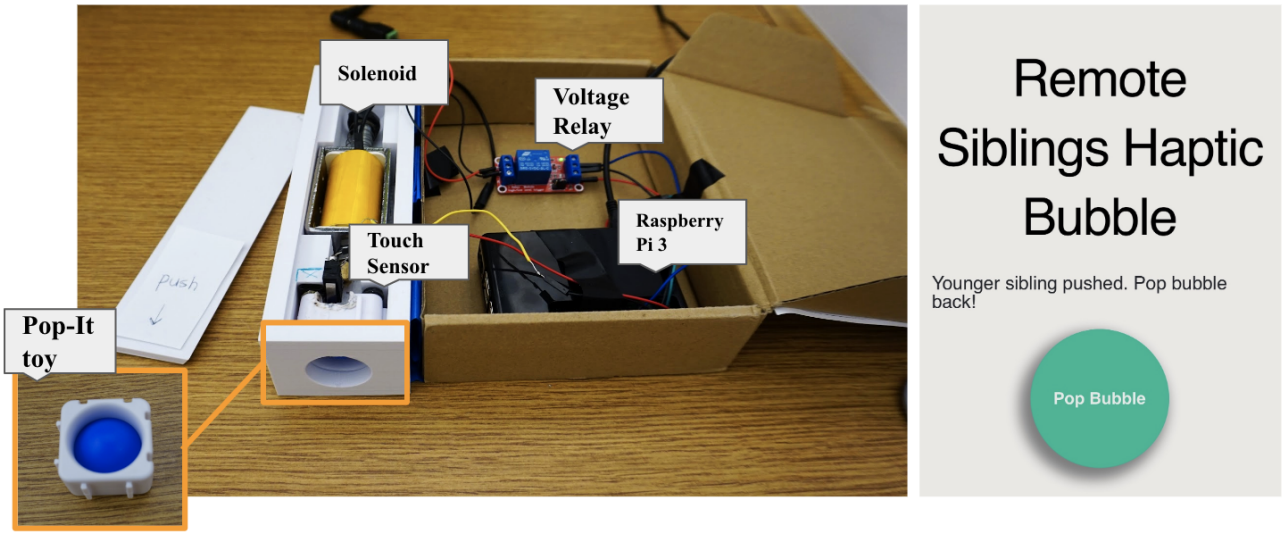

Figure 1: Haptic Bubble Probe. Younger siblings press the Pop-it toy on physical device, which updates the associated web page and sends a notification. Older siblings can virtually "pop" this toy back into its neutral state by pressing the button which triggers the solenoid on the younger sibling's device.

Haptic Bubble works like a haptic robot, where younger siblings will have a physical Pop-it toy to push. The blue portion Pop-it toy in Figure 1 is a pushable button made of a silicon material that can be popped-in or out.. Each push by the younger sibling pops the toy inwards on their end and sends a notification to the older sibling of the younger sibling's push. From this website, older siblings can "pop" the younger sibling's toy out remotely. This prototype allows for semi-synchronous communication giving siblings flexibility to communicate with one another on their own time and sets up a playful way for children to initiate interactions. Our current model has a Pop-It fidget toy with a 12V plunger solenoid placed behind it. There is a sensor placed under the bubble that triggers when the device is pushed. An image of the physical hardware and web server is shown below in Figure 1.

Emoji Board allows siblings to communicate more emotions than a simple touch. Younger siblings have physical emoji tokens that they can scan to automatically populate in a chat box to send to their siblings. In turn, older siblings can access the same chat to send emojis and texts back to the younger sibling. Both siblings have the ability to send and receive messages. Younger siblings will access this through a screen attached to their physical set-up and older siblings through their personal devices. This technology probe model consists of 25 circular laser-cut tokens that had an emoji on the front and an Radio Frequency Identification (RFID) sticker on the back. These emojis were chosen based on informal research done on the most popular emojis that could capture a wide range of emotions. The physical component included an RFID reader that was set up with the Raspberry Pi and connected to an Liquid Crystal Display (LCD) touchscreen. A live chat feature was created with Flask modules, to allow siblings to customize room names and see the chat history of messages. Since the younger sibling's system didn't have a mouse and the touch screen was relatively small, two physical buttons were added to the system: one to send messages and the other to delete the last scanned emoji. The system can be seen in Figure 2.

5 PRELIMINARY PILOT STUDY

5.1 Method

In order to learn how our technology probe meets the goals (see section 4) of the study, we conducted a preliminary pilot study for two sibling pairs. We obtained consent from both siblings and their parents. The first sibling pair (OS1, YS1) are 21 and 11 years old where the older sister has been living on campus and the younger sister at home with their parents for 4 years. Their typical interactions are through their parents' phones. The second sibling pair (OS2, YS2) are brother and sister who are 19 and 12 years old and have been living separately from each other for about a year. Both OS2 and YS2 had their own phones and use Discord [1] to communicate.

During the 45-minute session, we first introduced each of the two tech probes and gave siblings 5 minutes to explore and play with each system in different rooms. Younger siblings had the physical devices with them and older siblings interacted with the web application for each through a laptop. Following each exploration period, we conducted a joint interview with both siblings in the same room, and encouraged the younger siblings to respond first. We asked questions regarding the system feasibility and their experiences of using the probes (e.g., What parts of this probe do you like/dislike?). Finally, we asked them to brainstorm new designs about embodied communication (e.g., Based on your experience using the bubble, what do you see as opportunities for new kinds of systems that communicate touch?). We present our initial insights from the observations notes from the interviews.

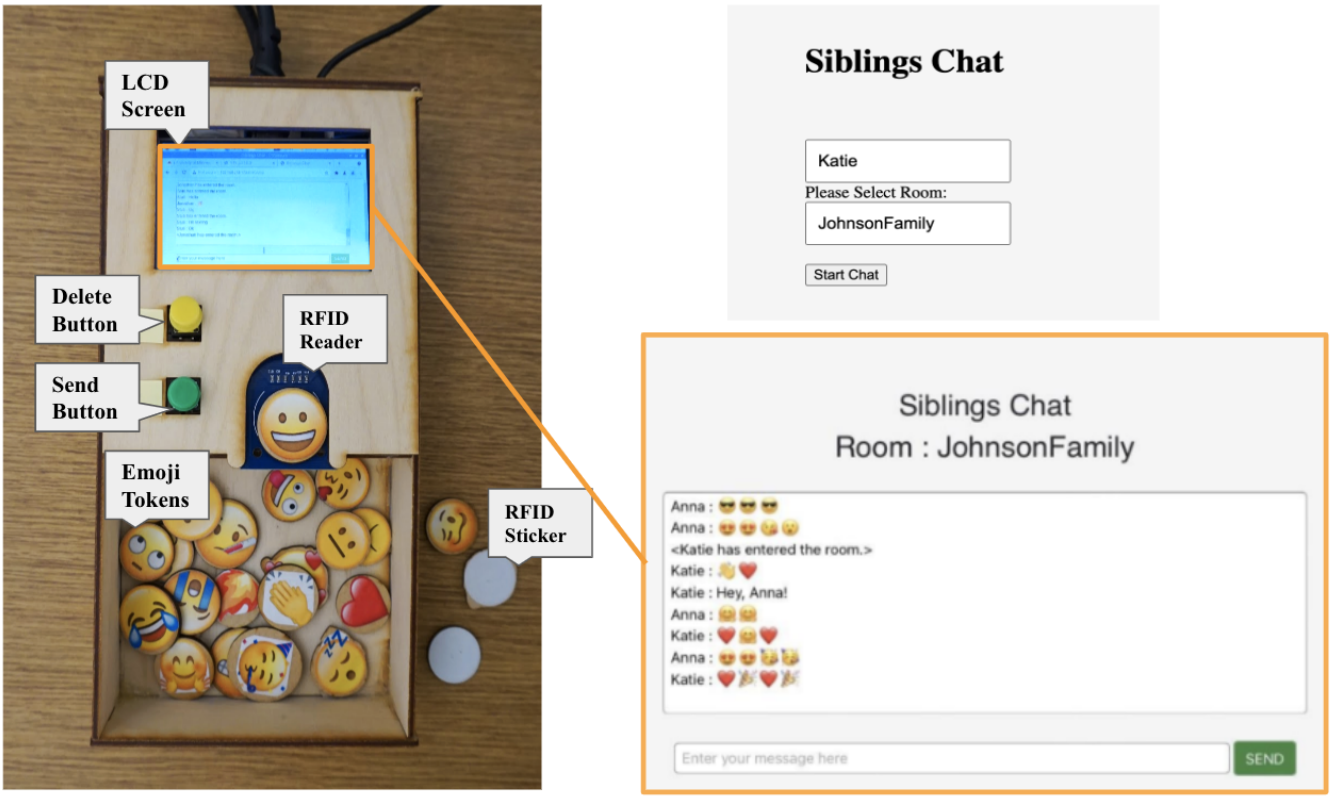

Figure 2: Hardware and interface of Emoji Board for younger siblings shown on the left. Close-up of chat shown on the right. Older siblings can access this webpage through the mobile phone. The image on the top right is the login page for different pairs, where older siblings logged in to match their younger sibling at the beginning of the study.

5.2 Results

We show a breakdown of results regarding each of the goals discussed in section 4 to answer our research questions.

System-building goal: To provide evidence regarding the feasibility of the embodied approach, we asked questions related to acceptability and practicality. Specifically, we wanted to understand to what extent is embodied approach judged as suitable, satisfying, or attractive to siblings and to what extent can embodied approach be carried out with siblings using existing means and circumstances and without outside intervention. The results showed that younger sibling thought Haptic Bubble and Emoji Board was more attractive than text based communication. When asked about how YS1 felt while using the Emoji Board, she said "Yeah, it was really fun. Way more fun (than texting)". Interestingly, even though there was only a year of difference in age, YS2 didn't have the same experience with the Emoji Board, likely because she was already comfortable using emojis through other communication mediums. She hypothesized that the device would been "far cooler" to use when she was younger. Despite this, YS2 ranked the Emoji Board as her first choice over the Haptic Bubble and their regular communication channels when asked how she would want to share exciting news with her brother. Additionally, both sibling pairs pointed out the Emoji Board allowed for some teasing and playful interactions between the siblings, as older siblings asked questions and younger siblings responded with strings of emojis.

Empirical goal: To collect information about how siblings use technology, we observed both siblings as they used their respective interfaces. During the studies, both pairs were able to engage in communication while using the two probes. After initiating the conversation, YS1 spent any time waiting for a response from her sister by organizing the emoji tokens into categories based on their meaning. We saw a consistent theme of younger siblings enjoying the fact that they could capture their older siblings' attention quicker with the Haptic Bubble. In comparison to calling or texting, Haptic Bubble was an easier way for them to initiate communication. YS2 pointed out "I feel like you've probably maybe gotten annoyed with it if I keep pressing it. But it's a good way to get attention". Beyond just attention grabbing, YS1 said she liked the Haptic Bubble a lot because she could "annoy her sister" - something she no longer can do with her sister living away from her. OS2 and YS2 both felt that they could use the Haptic Bubble along with text/audio call to supplement their communication.

Design goal: When we asked them to brainstorm future technologies about embodied communication, sibling pairs brought forth many ideas, ranging from physical bookmarks that could

share with older siblings where younger siblings are in a particular book to customized vibrations that feel like a touch to indicate a message or notification from a younger sibling. YS2 suggested a Teddy Bear that could store hugs and voice messages. Generally, we observed that both siblings suggested and got excited about ideas that would bring playful elements to communication technology. Overall, these ideas showed interest in more modalities of haptics, like tracking head and hand movements or converying realistic "touch". Immersive environments through Virtual Reality could provide these additional elements.

6 CONCLUSION AND FUTURE WORK

The Haptic Bubble and Emoji Board systems build on previous works in strengthening relationships between large age gap and long-distance siblings by providing appropriate mechanisms for users to interact with each other. We received feedback from two sibling pairs to preliminarily evaluate our goals. The iterated version of the Emoji Board will include short-text tokens to provide both siblings an opportunity to engage in conversation. The next version of the Haptic Bubble will also have the ability to receive notifications on mobile devices, instead of just on laptops, to maintain the semi-synchronous system in a convenient means. Additionally, immersive systems are a good way to support embodied communication, so we plan to create a VR system [14] as another tech probe. In order to see the long-term impact that these systems can provide, we hope to run a field study over multiple weeks with sibling pairs who are physically separated over a period of time to analyze the efficacy of the technology probes.

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