

Family Story Play: Reading with Young Children (and Elmo) Over a Distance

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ABSTRACT

We introduce Family Story Play, a system that supports grandparents to read books together with their grandchildren over the Internet. Family Story Play is designed to improve communication across generations and over a distance, and to support parents and grandparents in fostering the literacy development of young children. The interface encourages active child participation in the book reading experience by combining a paper book, a sensor-enhanced frame, video conferencing technology, and video content of a Sesame Street Muppet (Elmo). Results with users indicate that Family Story Play improves child engagement in long-distance communication and increases the quality of interaction between young children and distant grandparents. Additionally, Family Story Play encourages dialogic reading styles that are linked with literacy development. Ultimately, reading with Family Story Play becomes a creative shared activity that suggests a new kind of collaborative story telling.

Author Keywords

Reading, children, literacy, grandparents, video conferencing, agent, dialogic reading, family communication

ACM Classification Keywords

H.5.2. Information interfaces

General Terms

Design, Human Factors

INTRODUCTION

As families become more geographically distributed, new trends of technology adoption are emerging around the topic of family communication. For instance, the proliferation of

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Figure 1. A 2 year old interacts with Elmo while her grandmother reads a book over video chat.

affordable video conferencing technologies like Skype™ has sparked a trend in families building rituals around video communication tools [1]. While video conferencing engages children with long distance family considerably better than telephone [2], long-distance family members still report challenges in connecting and engaging with each other. There is an opportunity to create new tools that help families – especially the young and old – to connect over a distance.

Our work is motivated by evidence that young children and long distance grandparents often have the most time and desire to communicate, but have the most difficulty using today’s tools [2]. Tools like telephone or Skype are difficult for young children for a number of reasons. Both parties must have sophisticated conversational skills (and young children rarely do), and while children can show knowledge and ideas over video through action, they do not engage in conversations with remote family for long periods. In fact, even when co-located adults interact with young children they do not have a *conversation*, but rather they *play* together. We believe the challenge for remote communication with young children is to enable family members to play together remotely, and as children learn through play, to connect through a shared learning activity.

We are pursuing a new direction in communication tools for children and elders in which media content plays a role to enhance children's interpersonal relationships with long-distance family. Our approach engages children in "dialogic reading" in which children's literacy learning is enhanced by parents and educators who actively engage the child in thinking and talking about the book content. These techniques have been shown to have a significant positive effect on expressive vocabulary for 2-3 year olds, which is predictive of reading skill at age 9-10 [7, 13, 22].

Previous research has demonstrated the potential for the development of literacy-based content that engages family connectedness around literacy topics through a variety of media platforms (not just around books) such as edutainment media that coaches parents in literacy teaching [11, 17]. Such work foreshadows our approach, where media is cast as a dynamic tool in the context of social relationships and social learning. Hart & Risley [7] make a very compelling case that by the time they reach preschool, kids from poverty homes in the U.S. are at such a learning disadvantage based on their deficits in language learning in the home that school-based interventions can't help them catch up. In the Story Play project our goal is to design and build an intervention that teaches parents and distant grandparents how to help their very young children learn literacy skills at home, one that builds on distant adults' intrinsic motivation to connect with their youngest family members.

The established history of successful "edutainment" media such as television programming like Sesame Street foreshadows current trends where media can be used in a more flexible and social way to enhance a social learning in families [11, 17]. The trend is related to Vygotsky's thesis [20] that learning happens most effectively when children are *scaffolded* into a "zone of proximal development," that is, when a parent or educator tailors the educational content to provide challenges that are just beyond what a child could complete himself. In this trend, media is configured to highlight family members as foreground actors in children's engagement with educational content.

In Story Play, the Sesame Street character Elmo is designed to help a young child have a successful book-reading activity with a remote grandparent. Elmo initially acts as a guide to help the young child make the technical connection with a remote family member, and then helps spark open-ended discussions about book topics while engaging the child's sense of humor. During reading, Elmo models an interest in the book that may encourage children's interest and motivation. Overall, Elmo helps improve child engagement while he scaffolds dialogic reading (and discussion in general) around book topics.

RELATED WORK

Story Play builds on a variety of research including tools for video conferencing, intergenerational communication, interactive agents, interactive books, and educational media.

The CSCW community has addressed video in office and public environments, including early work like Mediaspaces [3]. Researchers addressing children and family have noted that video allows a greater sense of shared context and supports children to show knowledge that cannot be easily captured in words alone [21]. Our work builds on recent evidence that families are already using video tools to regularly connect [1].

Researchers of intergenerational communication have highlighted the challenges and requirements for designing for diverse user groups like young children and elders. Agile Aging [3] addressed shared activities for elders and younger family via augmented television, and projects like CASY have looked at asynchronous context aware communication [23]. Some work in interface design for distributed families argue for shared context and argue against always-on connections [6]. Other explorations [9] argue the opposite, and some like Sharetable [21] provide a shared context over video and suggest opportunities for remote book reading.

The use of Elmo is informed by previous work on pedagogical agents. Studies with older students have shown that the use of interactive social agents who communicate with students via speech and who express social and emotional engagement with the student and the task can improve student learning in multimedia environments [10, 12]. Our work addresses how an interactive agent can engage families in educational activities by supporting child engagement and scaffolding adult user behavior.

Our choice of book reading as a shared activity is inspired in part by evidence that reading (or being read to) remains a constant in most young children's lives [18]. Technological explorations of interactive books approach reading from multiple directions, including augmented paper books [8, 12] which add context specific audio to paper books. Many of these projects incorporate basics of toy design and point to trends in tangible interfaces for children's learning [13].

FAMILY STORY PLAY

The Story Play prototype was built explicitly to promote dialogic reading activities for children ages 2-3 in the context of long-distance family communication. The design focuses on supporting typical reading patterns such as physical page turning, and fitting into typical family reading rituals such as reading in bed before bedtime.

Our design is based on findings from early observations of families reading books over video chat, in which page coordination was a major topic of conversation, and child engagement required a lot of adult intervention. In our design, the main focuses include supporting child engagement with the remote grandparent by making the interface accessible and playful, providing technology to address page coordination issues, and coaching grandparents on how to use dialogic reading techniques to playfully engage with their grandchildren while reading books together.

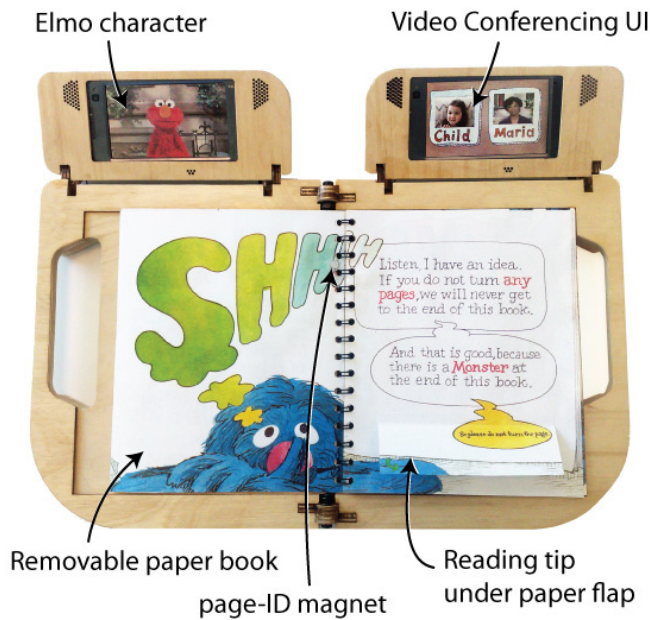


Figure 2. Family Story Play System

Primary system components

A custom tangible interface (“book reader”) houses a paper book, two touch-screen Linux internet tablets and page sensing hardware in a custom wooden frame that opens and closes like a traditional book (Figure 2). Paper books can be removed and replaced, with the book title automatically identified by the system. Multiple book readers connect to each other over wireless internet connections, or connect to a custom desktop application.

A paper book is placed in the book reader and its ID and current page are sensed by electronics housed in the frame. The two linux tablets are connected via USB to the page sensors, and to each other over Bluetooth, and present a two-part graphical interface to the child (and co-located parent): on the left is video content of Elmo, a software agent who can be dynamically accessed according to the software program. On the right is a custom GUI video conferencing application built with PyQT and the open-source telepathy stack.

The system is designed to meet the needs of both young children and older users, for instance simplifying much of the complexity of traditional video conferencing interfaces. Users are automatically logged in and can only select a small number of family members to be called. Different contacts are displayed as large photo icons so that even a young child can call his or her relatives (Figure 2) by touching their photo. Calls are answered by simply opening the reader and touching the picture of the person who is calling.

To address families’ challenges with page coordination over Skype, the Story Play video conferencing application also displays an icon of the *remote* reader’s current page, so that participants can coordinate reading the same page at the same time (Figure 3).

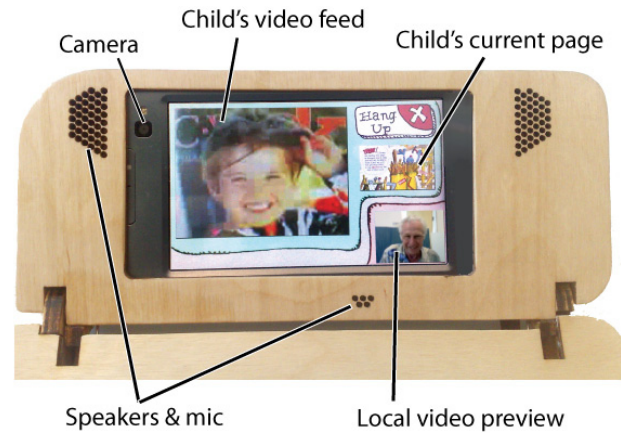


Figure 3. Video conferencing screen with remote page icon.

Elmo is a central part of the user interface, helping children (who are not literate) make phone calls, answer calls, and understand technicalities. Previous studies of family video calls [1] have reported the issue of children’s limited patience and tendency to participate in the call only for a very short time, usually under a minute. Our guiding design principle for having Elmo as part of the experience is that he can provide help with specific elements of the call such as initial call sequence, bringing attention back to the activity (book reading) and by prompting dialogue through specific questions and prompts that support our family communication and dialogic reading goals. His interactions all relate to the child’s perspective because young children cannot easily take the perspective of others, especially their remote grandparents.

Elmo’s role is conceived as a foreground actor when the video conference is not active. Before users are connected, Elmo will help guide the user. At the home screen Elmo will ask, “*Who do you want to read with? Touch the picture of the person you want to call.*” If there are technical difficulties such as a dropped call, Elmo will explain this, for instance encouraging children to wait and then dancing for them while he tries to call the grandparent back.

Once connected, Elmo takes the role of a story listener. His actions are synchronized for both parties (child and remote grandparent) to create the illusion that he is a third member of the story reading experience. Elmo encourages children to stay on the same page as their grandparent by offering comments when everyone’s physical books are synchronized. For example, a child and grandparent will turn to the same page of the book and read together. After a length of time Elmo will have an idea, represented by a thought bubble near his head. The child or grandparent will touch Elmo’s thought bubble, making him talk about the book, e.g. asking the child questions about the current page to encourage dialogic reading. “*Woah! Look at how big those letters are! How do you think Grover feels?*” While the system can support multiple books, we produced content for the single title *The Monster at the End of This Book* for our initial study.

Additional materials for remote adult readers

Special features are included in the grandparent's Family Story Play device to teach them how to engage children in dialogic reading.

A video, hosted by Sesame Street's Maria, coaches grandparents on how to easily incorporate ten tips into their reading styles (Figure 4). The video includes example footage of parents reading to children in a dialogic style. For example, grandparents are prompted to "ask 'what' questions." *What do you think Grover is doing with that hammer?* The video is displayed the first time the Grandparents use the system and it can later be accessed through a menu.



Figure 4. The Maria Video is shown to grandparents to teach them dialogic reading principles and techniques.

Maria's tips are also included inside the grandparent's physical book. Grandparents can lift small paper flaps in the book to discover a suggestion for how to open a conversation related to the book content (Figure 2). This is similar to teacher editions of books that have additional content in the margins. This, in addition to the contextual comments made by Elmo, provides scaffolding for grandparents to create a dialogue with the grandchildren about the book content.

Scenarios

An example scenario is based on the experiences of one family who Story Play in our user study:

"Nicky" is using Story Play with her dad and grandmother, who lives out of state. Nicky is 2½ years old and visits her grandmother about 4 times a year.

Grandma touches the photo of Nicky on her Story Play to call her granddaughter. As the call is connecting, Elmo says to Nicky, "*Ring Ring Ring! Someone special is calling. Touch the green button to answer the call.*" Nicky touches the picture of her grandma and then sees and hears her grandma say hello. Nicky waves, and Dad says "*Grandma is going to read a story.*"

Dad helps point along the text while Grandma reads on the other end. Dad sees the icons of Grandma's current page next to her video feed, and when Nicky turns too far in the book Dad turns the pages back for her and explains where grandma is reading.

Grandma reads: *YOU TURNED THE PAGE!* Nicky is reading along, when suddenly *Ding!* Elmo's thought bubble appears. Nicky presses on it and everyone listens to Elmo ask, "*Oh boy! Now Grover is speaking very loudly! How do you think Grover feels?*" Grandma repeats Elmo's question to Nicky, and Nicky laughs at the question.



Figure 5. Katie and her dad read, and then mimic Grover in the story while the grandparent reads to them over video chat.

During the story, both Dad and Nicky mimic Grover in the story looking exasperated with his hand on his head (Figure 5). Dad takes Nicky and the book in his lap and sits back. Nicky touches Elmo's thought bubble, often at her parent's suggestion, and laughs along with his jokes, or points to things in the book that he or Grandma ask about. After the story is over, Nicky wants to show Grandma her puzzle-piece numbers, and they say them aloud together before signing off and saying goodbye.

USER STUDY

The goal of the study is to help us learn, from both the Skype sessions and the Story Play sessions, their relative strengths and weaknesses in the remote reading scenario to help inform our design of future iterations of the Story Play system. The study also revealed much about how different people understand and relate to the system.

Eight families (24 participants) used both Story Play and a traditional video conferencing setup (which was similar to Skype, and will be referred to as "Skype" in this report) in a lab study. A small sample size was used to allow in-depth qualitative analysis to help in identifying strong and weak points of the different systems and to identify future directions. Our analysis focuses on four basic questions to address how long-distance family communication and dialogic reading can support each other:

1. How can technology support remote family communication and interaction for families with very young children?
2. How can technology help support remote family members to read with young children?
3. How can technology help provide a "shared context" for remote family reading and interaction?
4. How can a character who is familiar to and loved by young children help facilitate remote family reading and interaction?

Methodology

We recruited eight families with children between the ages of 2 and 4 (5F, 3M), their parents (6F, 2M), and grandparents (6F, 2M). Participants were selected for diverse income level and ethnicity. All except one worked in non-technology related fields. Two families reported using video conferencing in the past. After an initial intake, families were taken into separate rooms in the research lab (child and parent in one, grandparent in the other) to simulate remote calling from their separate homes. Each family participated in one remote reading session using Family Story Play and one reading session using Skype, with a short break in between.

In the Family Story Play sessions, grandparents were shown the “Maria video” (Figure 2) before the call. Each side (Grandparent, and remote grandchild & parent) had an identical copy of a Story Play device, and families read *The Monster at the End of this Book* by Jon Stone (Figure 6, top).

In the Skype condition, both sides had identical (traditional) copies of the book *Another Monster at the End of this Book*, also by Jon Stone, and read together using laptop computers with full-screen video conferencing software similar to Skype (Figure 6, bottom).

Researchers recorded front and back video on both sides of the call, as well as screen capture during video conferencing. After the sessions, grandparents and parents were interviewed about their experiences with both story-reading sessions. In general, methods followed recommendations for research with children [16].

The order of reading sessions (Family Story Play vs. Skype) was counterbalanced to reduce order effects. Children were often fatigued during the second reading, so we based our behavioral analysis on first sessions (Skype or Story Play) for each family. Thus, all behavioral data presented in the Findings section is based on coding for four families using Skype and four families using Family Story Play. In contrast, results based on interview data are based on all 8 families’ experiences with both sessions.

Videos were coded using a qualitative social behavior and social interaction coding scheme that was developed specifically for this project (similar to System for Observation of Children’s Social Interactions [4]). Coding focused on behaviors of the child, parent and grandparent while reading each page of the book. Choosing the page as a unit of analysis for each family gave us a number of data points for each subcategory measure, as is typical with small-sample-size, in-depth qualitative analyses.

The coding scheme included five broad categories, with verbal and non-verbal components in each category.

Book Content: verbal and nonverbal behaviors related to the content of the book, including dialogic reading behaviors. Subcategories included how many questions grandparents



Figure 6. One family uses Family Story Play (top) and another uses Skype (bottom) to read over a distance.

ask about the content of the book, how often parents clarify or repeat questions, and whether or not parents point to items on the page.

Affect: behaviors reflecting positive or negative emotional responses to the book. Subcategories included verbal statements or questions (e.g. “I like this book, do you?”) or non-verbal cues such as laughing, kisses, squirming, or audible sighing.

Attention / Engagement: indicators of whether the child was on-task. Subcategories included percentage of time the child appeared disengaged, and coding for any verbal or nonverbal prompts for attention on a page (e.g. “Listen to grandma”).

Page Coordination: behaviors and dialog around turning pages. Verbal subcategories included question or statements about page coordination (e.g. “I think grandma is on a different page.”, “Let’s turn the page now.”). Non-verbal actions included the number of pages where children turned away from the grandparent’s page, and pages where parents held down a page to prevent the child from turning.

Interaction with Elmo: examined uses of Elmo. Subcategories included number of times participants touched the screen interface, as well as verbal and nonverbal responses to Elmo (smiling, looking at screen, talking).

All of the coding categories were applied to both Skype and Family Story Play except the Interaction with Elmo category which was applied only to Family Story Play. This final coding scheme [19] evolved through the process of establishing inter-rater reliability (established at 91%). Once coding was complete, percentages were determined in each behavioral subcategory for each family across all of the pages of the book, and averages were calculated for the families using Skype vs. the families who used Family Story Play.

Findings

Findings are organized according to our four basic questions, outlined earlier.

1. Support of long-distance communication for families with very young children

We were interested in whether Story Play could improve the level of family communication and interaction over long distances. Confirming previous study findings for children in this age range [1], parents in our study reported that normal telephone conversations between young children and their grandparents are short-lived and meaningful exchanges usually do not occur. One father described a typical call: *“She’ll just go on the phone and say, ‘Hi Gram. How are you? I’m fine. Okay, bye.’”*

By comparison, in our lab study both Skype and Family Story Play book reading calls lasted much longer on average than a typical phone conversation in this age group. Skype book reading calls averaged 8 minutes and 23 seconds and Family Story Play calls averaged 11 minutes and 48 seconds (Table 1).

Skype	Family Story Play
(F1) 4:37	(F2) 24:01
(F3) 8:37	(F4) 8:31
(F6) 10:02	(F5) 6:35
(F7) 10:17	(F8) 8:05
average 8:23	average 11:48

Table 1: Session Length (min:sec)

The *quality* of these calls also seemed to be much higher than what is typically reported. In terms of attention, families were highly engaged for both Skype book reading and Story Play. Perhaps the most notable finding is that child engagement levels remained high throughout almost all of the sessions. For each page of book reading, we coded the approximate percentage of time (100%, 75%, 50%, 25% or 0) that the child was completely disengaged from the activity (i.e., walked away, turned to face away from the book and screen(s), talked about something completely unrelated, etc.). Based on the inverse of this measure, children were engaged in the Skype sessions 84% of the time and in the Story Play sessions 97% of the time. Such high level of engagement for young children in both conditions, but especially the Story Play sessions, is striking given the previous data about family communication.

Participants seemed to enjoy both the Skype and the Story Play reading experiences. Grandparents expressed approximately equal levels of enjoyment with both experiences (smiling or laughing on 60% of the Story Play pages and 67% of the Skype pages), whereas both parents and children showed distinctly more enjoyment of the Story Play experience than the Skype session. Parents smiled or laughed on 90% of the Story Play pages and 54% of the Skype pages, while children smiled or laughed on 78% of the Story Play pages and 29% of the Skype pages. It is possible that parent enjoyment

increased for Story Play in reflection of children’s increased enjoyment.

2. Support for long-distance family members to read with young children

In addition to supporting a longer and richer family interaction, we were interested to see whether remote book reading could be a tool for improving children’s literacy skills. Children’s first reactions to Story Play and Skype give some evidence about their orientations to the role of books in each scenario.

In all of the Story Play sessions children were eager to start exploring the book and other aspects of the prototype. They touched the book or flipped through it, even before the connection with the grandparent was established. They were likely encouraged to relate primarily to the physical book because of its position on top of a book reading frame and centered below the two screens (Figure 6).

In the Skype sessions children seemed to casually discard the books nearby and did not seem interested in them until later in the session when the grandparent invited the child to start reading. The larger screen area in the Skype sessions placed grandparents in a more prominent position (Figure 6) and sometimes the interaction would start with chatting and the book reading would not be initiated for a few minutes. In the Skype sessions, Grandparents frequently initiated the book reading by displaying the book to the camera. Parents would point to the physical book and its image on the screen to signify to the children that both sides had a copy of the same book.

Story Play was designed to facilitate richer interactions around reading, particularly to help families engage in the kinds of dialogic reading techniques that are known to help improve children’s literacy skills. The core techniques were described to grandparents in the “Maria Video” that was part of the Story Play prototype. As an indicator for this aspect of the design, we looked for how often Grandparents incorporated two of the techniques, asking questions and giving positive reinforcement, into their reading.

Grandparents in both conditions asked children questions related to the content of the book (e.g. “What is Grover doing?”, “Are you afraid of monsters?”), but grandparents in the Story Play condition did so more often than those in the Skype condition. Skype grandparents asked an average of 1 question per page while Story Play grandparents averaged 2 questions per page. Children answered their grandparents’ questions verbally about once per page in both reading conditions. Grandparents gave children positive reinforcement for answering questions or talking about the story (e.g., “Good job!”, “That’s right!) slightly more often per page in the Story Play condition (11% Story Play, 4% Skype pages).

Because Story Play was designed for learning in a social context, we investigated the scaffolding role parents played

in the reading activity. In both conditions, parents frequently pointed to the text on the page (or used the child's hand to point) while the grandparent was reading (30% Story Play, 40% of Skype pages). Parents also often served as a kind of intermediary or translator between the child and grandparent, clarifying or repeating something that either the child or the grandparent had said. On average, instances of this occurred about once per page in both the Skype reading sessions and with Story Play. This indicates that for both Skype and Story Play, remote reading was a shared family activity in which the parent was an essential participant.

3. Providing a "shared context" for long-distance family reading and interaction

In early pilot studies of book reading over Skype, we observed that many of the difficulties experienced were related to page coordination. To address this challenge, sensors in the Story Play book frame were built to transmit the state to the other side about the currently displayed page and thus help the page turning and synchronization. We felt that making page coordination disappear into the fabric of the technology would help support families in feeling like remote book reading was a truly shared experience. However, the feature did not have the effect on page coordination that was expected.

Curiously, despite the built-in page coordination feature, families were on different pages about twice as often with Story Play than they were with Skype (53% of pages SP, 24% of pages Skype). Also, both grandparents and parents scaffolded page coordination verbally (e.g. "Let's turn the page now," "Let's find the page Grandma is on."), about three times as often in Story Play than in Skype (every page, and once every three pages, respectively, for both parents and grandparents). Why didn't the page coordination feature help with keeping them on the same page?

One possible explanation is that the design of the page coordination feature was not always functional or understood. An unfortunate constraint of the design was that the pages of the book need to lie flat in its casing in order to be sensed, and there were some instances where this resulted in the wrong page being transmitted. Some participants reported later that they did not understand that they could tell from the image window what page the other was on.

Another possible explanation is that parents may have allowed children more agency in page turning with Story Play. We observed in both Skype and Story Play sessions that children had a tendency to flip through the pages of a book more quickly than could be read by the grandparent, or would skip around randomly from one page to another rather than turning the pages one by one from first to last. However, children turned to the incorrect page more often with Story Play than in the Skype condition (54% of Story Play pages, 33% of Skype pages). Furthermore, parents physically held

children's hands to prevent page turning about twice as often when using Skype (62% Skype pages, 30% SP pages). It seems that parents were more willing to give children an active role with Story Play, whereas in Skype they felt more compelled to control the children's experiences.

4. Elmo's role to facilitate remote family reading and interaction

Elmo was introduced to help children engage in a book reading activity, and the children were quite interested in and engaged with him. The number of times Elmo appeared varied, depending on the family's behavior with the book. As previously noted, Elmo's thought bubble (indicating that he has a comment) only appears when child and grandparent are on the same page for a fixed amount of time. Children touched Elmo's thought bubble, on average, 68% of the time that it was available. Two were engaged to an extreme, frequently moving their faces very close to the screen as if to rub noses or kiss him and saying "Hi Elmo" or waving at the screen quite frequently. For example, one of these children touched the Elmo "thought bubble" 10 times during the 7 times it popped up on screen and 12 times when the bubble was not even on the screen.

In designing Family Story Play we knew that the introduction of such a popular figure like Elmo could also backfire: children's attention may be completely directed to Elmo, overshadowing the grandparent's presence and book reading activity. Our observations of the Story Play sessions suggest that we haven't yet found a precise set of guidelines in how to design for this very complex (social + media) interaction. However, we can report that the following three patterns of interaction emerge:

Elmo and Grandparent collaborate in story reading:

This was our ideal interaction and one of the of the primary design goals. There were examples of grandparents using Elmo to bring the children attention to the story and book topic. In one family grandma reinforced Elmo's question by asking several times, "Did you hear what Elmo said?"

Grandparent as the center of the show: This was the less likely of the scenarios, but it still happened, such as in case of Family 2. The grandma in this session was very articulate and did reading in a very theatrical way. In an interview, she explained:

"You know, it's like if you're not theatrical, this is something that – something that you really have to become theatrical with. You cannot hold a child's attention span if you're just reading. You've got to be – you've got to do the TV thing... You've got to find a way to hold their attention span, whether it means, you know, jumping up and down like I did, clapping and doing all those things. That's what you've got to do so they can be interested and really enjoy." (Grandma, Family 2)

Elmo as the center of the show: Younger children quickly understood that Elmo could be touched to cause some reaction. Elmo's thought bubbles (that would appear once both sides are on the same page for a period of time) tended to grab the attention of the parents who would then point this out to the children. Sometimes grandparents would try to read while Elmo was talking, and children's attention would be to Elmo, not to the story or to the grandparent. This could cause frustration for the grandparents, who would have to reread sections of the book. One grandparent even lamented, "I think he likes Elmo better than me." While children were often engaged with the Story Play activity, some grandparents seemed to feel the children were not fully engaged with *them*.

The Elmo interaction design was not understood by all of the children. Elmo's thought bubbles were not adequately explained or demonstrated to all of the users. One child didn't discover the thought bubble functionality until her parent pointed it out late in the session, and she touched it two out of the three times that it occurred from that point on. One child never discovered the functionality. Another aspect of the Elmo design that needs improvement is better definition of Elmo's role vis a vis the grandparent's role. As a result of the varied social interactions we observed around Elmo's presence, we are working to improve the interaction design to leverage the strengths of both the grandparent and Elmo in ways that enhance families' experiences with both literacy and communication.

DISCUSSION

Emerging from this mix of people and technologies is a system that begins to suggest a new kind of collaborative story telling. Reading with Story Play is a creative act, one which promotes engagement far beyond the book. The evidence of Family 2 spending 24 minutes to read an eleven-page children's book points to this phenomenon. The longer duration of both Skype and Story Play sessions compared to normal Skype sessions suggests that other shared activities around narrative content could also promote and enhance long-distance connectedness.

We believe that the long durations of the sessions indicates a synergy between book reading and long distance family communication. Family Story Play was designed to optimize this experience for children and grandparents, through the use of dialogic reading videos and prompts, the use of Elmo to increase child engagement, technical simplification of video conferencing UI, and portability to fit within domestic book-reading rituals.

Children's attention and overall engagement

While grandparents had varied opinions about the level of interpersonal engagement with their grandchildren using Family Story Play, overall they reported an improvement over existing tools. Many participants said that just seeing each other helped maintain engagement. As one grandmother

put it, "*Gees, it's just 100% better...So it's like if you can see them, it pulls them in, you know. Then you can start asking questions, see their actions...Get that whole conversation going.*" (Grandmother, Family 3)

Children's increased enjoyment in Story Play over Skype could be in response to the presence of Elmo alongside seeing their grandparent on video. Children demonstrated their excitement about Elmo by waving to Elmo, greeting Elmo, touching Elmo's screen (Figure 1), and through physical affection:

"*Elmo? She loved it. You saw her. She tried to kiss him.*" (Parent in Family 4)

Providing a shared play activity seemed to help ground families' interaction. The reading of the book provided context and content for all family members to share and seemed motivating to the grandparents. One grandfather said he thought the shared context helped. "*Oh, I think it's still better than talking on the phone. Well, you have something to talk about....*" (Family 5).

Parental role

As reported in previous studies [1], parental role is essential in the flow of the video call and overall interaction. Parents are the ones who do most of the work, from setting up initial calls, to arranging everyone physically in the room, to initiating conversation, suggesting topics, giving prompts, keeping children in the frame, etc. In Family Story Play parental role was still very essential (although different from normal videochat) in our sessions. We noted cases of parental encouragement to interact with the grandparent (for both Story Play and Skype) by modeling desired behavior (e.g saying hi to grandma, positioning themselves in front of the camera, waving). In the Skype condition, one mom repeatedly had to position her child by holding his chin and turning his head towards the camera.

Quite a few parents were essential in book reading, since they were the ones to (re)synchronize page flipping and monitor the overall state on both sides. Several parents also chose to point with their or their children's finger to particular words as they were read, suggesting more formal steps towards learning how to read and overall literacy.

Story Play form factor

All children reacted positively to the fact that the book was in front of them and that they could flip the pages. This was especially true for younger children, who clearly showed their impatience by starting to flip through the book. Children's interaction with the book pages was encouraged by the content of the book: *The Monster At The End of This Book* has a playful suspenseful narrative that progresses with warnings like, "Do not turn the page! There is a monster at the end of the book!"

The book facilitated tangible interaction in other ways as well. In Family 7, "Charles," 3 years old, pounded his fist on

the pages along with Grover, who was nailing them together. He continued pounding for the rest of the book, seemingly delighted that he could physically participate in the whole activity. His grandfather later reported in an interview that he too was delighted. Hearing his grandson pounding away at the pages helped him know that the child was engaged in the story.

Although the Skype setup did not facilitate page-synchronization (and parents and grandparents synchronized page turning by frequently checking with the other side about the current position), many grandparents remarked that the larger screen in Skype gave them more awareness of their grandchild's experience:

"The first one I loved, because it was the larger screen. It's on the computer; I could actually see her and her reactions. On the second one you don't really get that; you kind of have to try to fit and, you know, and I can't really see her reactions or grab her attention. But I love the fact on the second one that I can tell what page she's on, so then this way I can try to, you know, jump back to wherever she was at, or if she jumped forward, you know, kind of work her back to where we were at. So they both had their things I liked and things I didn't." (Grandma, Family 3)

The contrast between children's and parents' preference for Family Story Play, and grandparents' general preference for a large screen suggests opportunities to create an asymmetrical system in which children have a tangible Family Story Play system and grandparents have a more traditional desktop-based Story Play software application.

Designing Elmo's role to support family relationships

We introduced Elmo to improve the child's experience and attention, and to thus improve the experience for the grandparent as well. Children's overwhelming attraction to Elmo and preference for the Story Play system suggests that he is helping to engage their interest, and make video conferencing more "child-friendly." However, Elmo is quite literally a star for the children, and as such he was at times a competitor for the grandparents. Almost all grandparents responded positively to the idea of having more direct control over Elmo's behavior so that they could use Elmo to help them engage and entertain the child, rather than having to compete with him in those regards.

The fact that Elmo could potentially play a critical role in helping grandparents open discussions with the children and keep them engaged in the interaction, thus facilitating family communication and connectedness, demands that we extend our efforts to create an interaction design where Elmo's role is better integrated into the context of the grandchild-grandparent social dynamics.

Children's sentiments that they look forward to this kind of activity suggests we are on a path to designing technologies to improve remote family communication. We heard from one parent that "children know the beep of the skype call."

Our work suggests that designing technologies around child-centered content can help make the experiences more salient for children, while scaffolding parents and grandparents in successful educational and communication strategies.

FUTURE WORK

Children preferred Story Play and seemed to respond to the physicality of the book and the presence and help of Elmo. In contrast, grandparents responded to the large video images from Skype and seemed more comfortable with the desktop computer. In future studies, Grandparents may prefer to connect to a child's Story Play device with custom software on a desktop computer that features a larger child image and the benefits of Elmo and page synchronization.

We are also continuing to refine the roles and interaction around Elmo. Our major design challenge going forward is finding creative ways to integrate the roles of grandparent and Elmo in the flow of the interaction with the child, while finding ways to lessen the competition and increase the potential for a successful collaboration of grandparent and Elmo in the service of both family connectedness and children's literacy learning. Basic approaches to this problem may include providing coaching for grandparents (perhaps in the "Maria Video") on how to effectively use Elmo to engage children, or even providing grandparents means to bring Elmo into a conversation with the child.

Furthermore, as we design for an in-home, longitudinal evaluation, families' comments make clear that the system should support more than one mode of use. A parent-child reading mode could support dialogic reading between co-located family members. Families with busy schedules and time zone differences also reported that an asynchronous story-recording mode could help address basic logistical challenges. Maintaining the sense of grandparent-grandchild engagement will be a central challenge in these experiments.

Based on our current results, we intend to implement these design changes and to conduct a longer evaluation in the home to address questions of novelty effects and ecological validity. We are working towards increasing the amount and quality of interaction between long distance family members while supporting children's learning through the attention and effort of the people who love them.

CONCLUSION

Story Play addresses the hypothesis that there is a synergy between young children's education—in this case, a rich shared reading experience—and communication with long-distance family.

Story Play introduces the Sesame Street Muppet Elmo as an important element of the user interface. Elmo is both a guide to making and receiving video calls, and then becomes an active listener and participant in the story-reading experience. Elmo is a facilitator: when touched, he asks children open-ended questions about the book content to spark dialogue

between grandchildren and grandparents. Elmo entertains children and models an interest in reading that children may emulate, and is available to help grandparents engage grandchildren over a distance.

Reading with Family Story Play shows promise as a means to improve the quantity and quality of interaction over video chat between grandparents and grandchildren, and in addition has the potential to support a kind of grandparent-grandchild interaction that will promote children's literacy learning. Furthermore, children are more engaged with the book itself and parents may give children more agency in reading with Story Play than when reading a book over Skype.

We are extending the traditional role of children's media by using it to support children's education via relationships with their long-distance family. By engaging grandparents in a rich long-distance book reading experience with their grandchildren, Story Play has shown that communications, education and entertainment can converge in a shared activity context enabling young children to play, learn and connect with people who love them.

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