Pokaboo: A Networked Toy for Distance Communication and Play

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ABSTRACT

How might we build on the physical interactivity of children's play to help children communicate over a distance? *Pokaboo* is a networked toy for children ages 2-5 to physically play even when they are far apart. Envisioned almost like a low-frame rate video chat, the system combines physically-linked buttons with photo and audio communication. A child will press a button down to take their own photo, and their self-portrait will pop up on their partner's device. The device was tested with both photo sharing and video chat. Children were most engaged when the buttons were part of a mobile video chat, where one child could press a button down and see their partner's button pop up in front of their far-away playmate. When the playmate responded with a button press, their button would magically pop up in front of them, in a form of physical call-and-response. Pokaboo shows how networked toys can help children to form engaging connections through physical play over a distance.

Author Keywords

Video conferencing, networked toys, distance play, family communication

ACM Classification Keywords

H.5.2. Information interfaces; H.4.3. Communications Applications: Computer conferencing, teleconferencing, and videoconferencing

General Terms

Design, Human Factors

1. INTRODUCTION

While adults have many tools to stay in touch when apart, tools like telephone, emails, sms, facebook, etc. do not meet children's developmental needs. Still, they have human needs – to connect with the ones they love. How might we design communication tools that specially consider young children's emotional and developmental needs, and help them to form more meaningful connections with their distant friends and family?

Our view is that communication tools, by their very nature, create *media* through play, and this can be leveraged. Tangible tools may be purely tangible, but children's input may trigger the creation of multimodal experiences, such as creating images or videos. Seen as media tools, children's toys may enable new forms of play and communication between children and their distant family and friends.

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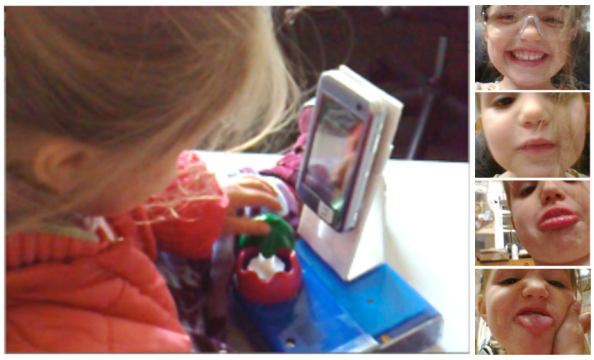

Figure 1. Child creates self-portraits that are sent to a partner.

Our approach builds on a recent trend to investigate how distant children can play with each other [[10]]. One aspect of this distance play is the play itself - how may children share objects and experiences when they can not be together? One opportunity may be to connect children's toys themselves, creating networked toys that children may share even when they are apart. This approach builds on the history of tangible communication tools like inTouch [3] but considers designs with a developmental approach: how may tangible communication tools best scaffold the play and communication of young children? We look to the classic designs of childhood toys and the patterns of children's play, finding inspiration in things like pop-up toys, pull toys and games like dress-up and peek-a-boo.

2. RELATED WORK

Recent work in Family Communication has addressed how specially designed tools for young children can help them to play at a distance with adult family members. These projects focus largely on situating video chat in the context of shared play activities such as reading books, or playing dress up or guessing games. This work builds on recent social trends in Skype use among families [[1]], and has sought to use video chat tools to help the young and old connect over a distance. Ballagas et. al have argued that video is more developmentally appropriate for the young, and that it is a more naturally shareable medium than

Figure 2. Cardboard mockup test with children ages 2 & 4.

audio-only tools like telephone [[2]]. One approach has been to create ways to play together over a distance. Family Story Play is a book reading system that combines paper books and mobile conferencing, to that an adult may read a story book to a child who is far away [[7]]. This system led to a 5x increase in video chat times for families with very young children, compared to Skype use alone. StoryVisit demonstrated similar results by providing web-browser based tools for families to engage in "connected reading" [[8]]. Follmer et. al proposed a series of lightweight games in "Video Play." Games touched on classic play patterns such as book reading, dress up, pretend play, and charades [[5]]. Their approach of open-ended play, informed by classic play patterns, is consistent with ours. Physical interactivity has been shown to make interactions more intuitive. Peek-a-Drawer allowed family members to share messages by placing personally meaningful objects into video-connected dresser drawers [9]. Tangible interfaces for children's learning also contribute to this trend in physical/digital integration [[6]]. Recent explorations into using toys as proxies for children's communication have begun to explore how children's play can scaffold distance communication that might otherwise seem to abstract for children to be comfortable exploring [[3]]. Our work builds on these trends of communication-through-play.

3. POKABOO

Pokaboo combines the play pattern of peek-a-boo with the action and suspense model found in the classic toddler hidden-box toys (figure 3). Our iterative designs incorporated the feedback of young children at every stage. We followed a number of assumptions:

- Tangible UIs will be more accessible to very young children than purely graphical ones
- Classic Toy designs can be leveraged to bootstrap any TUI designs to improve child engagement. They may also inform UI affordances.
- Classic Play Patterns can be leveraged to bootstrap UI designs and flow, including content any supporting content. Patterns can include toy and game play.

3.1 Paper Prototype

Explorations began with a goal to create the simplest possible communication tool for toddlers. Conceived as a "physical facebook poke" we adapted the notion of a toddler's pop-up toy to include a communication function. A cardboard prototype featured a plunger that penetrated a cardboard wall. Pushed in on one side, the plunger popped out on the other (Figure 2). To add an element of personality and play to it, the plunger was connected to a simple physical linkage which caused two photographs to flip 90 degrees when the plunger was pushed. One photo showed a person smiling, and the other showed the person hiding behind their hands. The result was that each person had an identical but opposite experience: when the plunger was pushed, the face would smile. When it popped back out (having being pushed by one's partner), the face would hide. We tested the prototype with the children of one of the researchers, ages 2 and 4. The father's face was used in the prototype to gauge the children's reactions to a person that they knew.

3.1.1 Piloting the Paper Prototype

The researcher introduced the paper prototype to his girls in their bedroom as a "new toy to play with." Then the toy was set before them with a simple explanation of how to push the plunger. Each girl sat on one side of the cardboard wall and was instructed how to push the plunger back and forth. The girls quickly got the idea and set to pushing it back and forth a number of times, laughing at the picture of their father hiding and smiling. "What do you see?" The older sister asked. The two girls investigated each other's perspectives, puzzled by the fact that they each saw something similar, but not at the same time.

The "equal but opposite" design was somewhat abstract for them, which is consistent with studies of egocentrism among toddler age children. The children's relative interest in the toy encouraged the research team to delve further into this approach to a messaging system for young children.

3.2 Functional prototype

We considered the physicality of the cardboard interface to be central to its success, and thus set to experimenting with a number of plunger and button type interfaces for children that could allow children to have a similar experience while in different physical locations. We chose to reach beyond the static images in the paper design and allow the children to take self-portraits and share these with distant friends. We assumed the self-portraits would be fun for young children to create and would provide personality and content for the messages to convey meaning to the remote partner.

A simple animated storyboard illustrated how networked toys might facilitate communication. Two hidden-object toys were shown to alternately create and share images with the partner. Pressed in rapid turn-taking succession, two partners could use the toys to effectively engage a very low-frame rate video chat (figure 3).

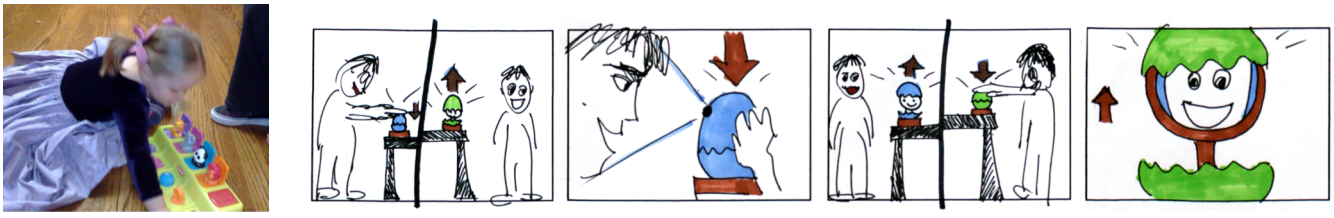

Figure 3. Experiments with hidden-door toys (left) lead to concept for physical photo-chat with networked toys (right).

Figure 4. Pokaboo combines networked physical toys with networked photo sharing or mobile video chat.

A functional prototype included 2 identical devices that were connected over the internet. Each device comprised a Nokia N810 internet tablet running a custom photo taking and sharing app, and a large spring-loaded button that connected to the tablet with a Bluetooth Arduino board (figures 1, 4).

3.2.1 Mechanical Design

The design of this system underwent a number of variations. Choosing the button and its mode of use was not immediately obvious. A number of "hidden door" toys were studied and adapted with electromechanical devices to make them act and react in unison over a distance (figure 3). While we considered continuous motion devices such as linear motors, this has been shown to be difficult to achieve over a distance due to latencies in the internet [[3]]. Thus, we chose a binary state actuator that could be either *in* or *out*. The state could be sensed with a simple switch, and the actuation could be easily controlled using a latch-spring system with a solenoid to release the latch.

3.2.2 UI Design

The system used the front-facing camera on the tablet and then display and share images between two paired devices. It also handled network communication to couple the two children's physical buttons and keep the states between them consistent. In operation, child would press down the large button, which would trigger a cash-register sound and cause their photo to be taken and displayed on the screen. The photo would animate downwards from the top of the screen, following the movement of the button itself. The photo would also be sent to the remote playmate, along with a signal for the remote button to be released to the "up" position. When one child created a photo, the remote playmate would see it animate up from the bottom of their screen, following the spring-loaded movement of their button. The intention was for the children to take turns sending photos back and forth.

This design enforced turn-taking by latching the child's button in the down position after it had been pressed. Because we assumed that in actual use the remote partner might not immediately reply, we allowed the child to press the button again even when it was locked in the down position. Although it would undergo only a very small amount of physical travel, it would create the sound effects and create another self-portrait for the child. It would also cause the remote toy to physically wiggle and make sound effects to get the remote partner's attention, in a sort of request for attention.

4. FORMATIVE EVALUATIONS WITH CHILDREN

After preliminary testing with children in our lab, the prototypes were brought to a home environment and shown to about a dozen children ages 2-5 in an informal home environment. Both children and their parents explored the use of the toys. They were shown to the children both side-by-side, so that children could grasp their sense of "connectedness" and then placed in different locations (one inside, one outside) to simulate distance. Children were invited to play with the devices, and a researcher noted their comments and use of the system.

The children and parents both enjoyed playing with the toys, usually taking about 5-10 self-portraits each. While the tangible UI was equally usable by all children, older children had an easier time staying in frame of the camera (especially when the devices were moved to the floor by the children). In general, the children enjoyed the interactions but seemed somewhat confused about how and when the button would pop up.

When the devices were not side-by-side, children and adults sometimes seemed confused about the sources of the images. When a child pressed the button down, their image would slide down into the screen, following the movement of the button. When a respondent's image arrived over the internet, it would slide up from the bottom of the screen as the button popped up. The screen thus showed two sources of images: the local images and the remote images. Children wondered, *what caused the button to pop up*? *Where did the image of the friend come from, and how did the child make it appear*? The invisible nature of the communication channel seemed to lead to this confusion. Following these mixed results, we made a number of minor design changes and then worked to test the system in-situ with a couple design variations.

4.1 Long-distance in-situ trial

Two families with children ages 2-5 had once been neighbors and close friends in the Boston area, but one family had moved to California, and the children still fondly remembered and spoke of each other often. This families were used to using phone calls and sending paper mail to keep in touch.

The devices were introduced to the families as "small computers that could do skype and also play this photo sharing game for the children." The families agreed to take the devices into their homes and use them as much as they wanted to for the course of two months. To accommodate logistical challenges, the researcher helped set up alarm clocks on the devices that would automatically turn them on at convenient morning hours so that the families could be reminded of their distant "play dates" [[10]].

4.1.1 Discovering synchronous remote physical play

The families initially experimented with both Pokaboo and separately with mobile Skype that was also possible with the prototypes. Pokaboo with photo sharing was somewhat fun and magical for the children, but children's stories and play with them were limited in comparison to conversations the children had using the mobile video chat. Pokaboo was used by the children more as a toy and less as a communication tool. However, even when using video chat, the children would press the button and try to use it. Following this observation, the researcher adapted the devices to operate in a mode that retained the physical connection of the buttons (one causing the other to release), but excluded the photo-taking and sharing.

Building on the children's dual interest in standard video chat an in pressing the buttons, the buttons were arranged in view of the

cameras so that the children could operate them while using "standard" mobile video chat. When one child pressed her button down, she would see their friend's button pop up in the video chat window that showed her distant friend's face and home. Like a long-distance see-saw, the children could engage in physical play together, laughing, pressing and talking to each other about the experiences.

In successive sessions, the families sometimes had trouble setting up the physical buttons (due to batteries dying, networking issues, etc.) but did continue to have mobile video chat sessions. Children often spoke of the tangible interfaces during these sessions and asked for them explicitly. Children pressed the buttons when they were off and requested to "play the button game" even when not connected to a remote playmate. Results indicate opportunities for more investigations into devices for children's remote collaborative play.

5. CONCLUSIONS

Pokaboo introduced turn-taking physical play to distant partners. In an initial photo mode, the device would create self portraits and send them to a partner. Formative evaluations led to the creation of a video mode in which the devices were coupled with mobile video chat and introduced physical turn-taking play to children's video chat sessions. One of the interesting findings is that the prototype seemed to work fine as long as children could see both sides of the device (either side-by-side in photo mode, or visible by the remote camera through video chat). Perhaps children need to directly and immediately *see* the effects of their work in order to understand them as causal. Another interesting finding is that children repeatedly asked to use the physical toys during regular mobile video chat when they were turned off, indicating that networked toys can provide a compelling and attractive form of distance play for young children who are engaging in mobile video chat. This final observation reveals avenues for future research in networked toys and games for children to physically play over a distance.

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