Chapter 6
Kids & Video: Playing with Friends at a Distance

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Abstract As children's use of technology grows, we see video as an important communication medium for children to connect with their friends and family members. This chapter describes a series of research projects focused on connecting children with their friends using video. The VideoPlaydate project explored children's use of synchronous video conferencing technologies to connect with distant friends and examined several extensions to standard videoconferencing systems to better support children's free play. In a follow-up project called IllumiShare, a novel hardware device was developed to enable any surface to become shared. IllumiShare allows children to easily incorporate any physical object into their remote play with friends, including toys, books, and games. The chapter also describes a project which explored children's use of an asynchronous video messaging tool called VideoPal to help children develop new friendships with Pen Pals from a different country or strengthen existing friendships with children they see on a regular basis. These research projects demonstrate the potential of video to connect children with their peers, and also identifies several important design recommendations that must be considered in systems to support children's remote play with friends.

Introduction

Video is an exciting new medium for children, especially in the ways that video conferencing technology can support children's rich social interactions with friends and family members. Many researchers have explored the potential of video to connect children with distant family members such as grandparents (Follmer et al. 2010; Raffle et al. 2011a, b), and travelling or divorced parents (Yarosh and Abowd 2011); however, video also has huge potential to also support children's interactions

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with their friends (Yarosh et al. 2010; Yarosh and Kwikkers 2011; Du et al. 2011; Inkpen et al. 2012).

Consumer use of video communication is expected to grow substantially in the coming years, from 600 million video chats in 2008 to just under 30 billion in 2015 (Poor and Wolf 2010). Interestingly, statistics on adults' use of video communication reveals that younger Internet users (ages 18–29) are more likely to use video calls compared to older adults (Rainie and Zickuhr 2011). While there is little data on the growth of video communication for children, children's increasing access to computer technology and their use of rich media could significantly add to the growth of video communication.

Many innovative prototypes have been designed to support children's social play. For example, sharing digital images was explored by Lindley et al. (2010) in a system called Wayve, which enables sharing of handwritten and photo messages to support social interactions within families. Although Wayve was originally designed to help families manage their practical affairs, user studies revealed that it encouraged playful use, particularly for children. Other work by Mäkelä et al. (2000) also showed that leisure sharing of digital images supports playful interactions (joking, expressing emotions, and creating art) to share current activities and feelings.

Connected toys have also been explored to encourage children's free play with remote friends. Bonanni et al. (2006) explored children's play using networked, wireless, robotic figurines called PlayPals. PlayPals consist of two or more dolls that are remotely synchronized such that when one doll is moved the remote doll moves in the same way. There are also tangible tokens that can be placed in the doll's hand to provide additional functionality such as voice and video communication. In a user study the concept of connected toys was very intriguing for the children; it enriched their play and gave them new ways to communicate their thoughts and feelings. However, the dolls alone were not enough—social play only occurred when the children were also provided with a synchronous audio connection. Yarosh and Kwikkers (2011) also recommended the use of remote toy interaction to support children's play. This could involve interaction between remote physical toys, or children's interaction with a virtual representation of a remote physical toy.

For reasons that this chapter will describe, video provides a unique opportunity for children to engage in rich, social play with their friends. In what follows, we explore the potential of synchronous and asynchronous video to support children's communication and play with their friends. These friends could be distant relatives, Pen Pals, or school friends that they see regularly. We first review the potential benefits of video communication for children. We then discuss the use of synchronous video to support children's free play and present results from the Video Playdate (Yarosh et al. 2010) and IllumiShare (Junuzovic et al. 2012) projects. We then present research on children's use of asynchronous video, including results from the VideoPal projects (Du et al. 2011; Inkpen et al. 2012). Overall design recommendations for children's video communication are then presented and finally we close with a discussion of the future potential of connecting children with video.

Video Communication for Kids

One of the key benefits of video is that it supports non-verbal communication such as the use of gestures, body language, facial expressions, and voice expressions (Mehrabian 1972), and can convey emotional signals to eliminate confusion in conversations (Ekman and Friesen 1968). Supporting children's non-verbal communication is important, since children's communication abilities are typically less mature than adults (Piaget 1926). Mediums that leverage actions, body movement or imagery might be easier for children to use than text based communication such as email (Bruner 1975).

Several Computer Mediated Communication (CMC) theories suggest that video could be a desirable medium to facilitate communication among children because of its capabilities in supporting nonverbal communication. According to media richness theory, video allows people to simultaneously observe multiple nonverbal behavioral cues, including body language, facial expression and tone of voice (Daft and Lengel 1984). Social presence theory points to the fact that communicating partners can have more awareness about each other's states using video than other media like email, text messages or over the telephone (Short et al. 1976). Furthermore, common ground theory suggests that enhanced mutual awareness among communicating partners provides grounding necessary for the development of conversations, thereby making communication more effective (Clark and Brennan 1991). The contextual information provided in video therefore suggests that it is a more effective medium for communication than text-based media, like email, IM, or SMS, or voice-based media, like telephone.

There has been a long history of research exploring synchronous Video Mediated Communication (VMC) in the workplace, however, much of the literature has failed to show benefits of video over audio on objective measures such as time to complete a shared task (Kirk et al. 2010; Whittaker 2003). However, studies in the workplace have found that video can enhance verbal descriptions with gestures, convey nonverbal information, express attitudes in posture and facial expression, and manage and interpret pauses, thus making communication more effective (Isaac and Tang 1994). Despite the extensive study of VMC in the workplace, and the plethora of enterprise systems developed over the years, usage continues to be relatively low.

In home settings, the use of video is growing rapidly because of a desire for closeness and has been shown beneficial to support people's desire to stay connected to family members and close friends (Kirk et al. 2010; Romero et al. 2009; Tee et al. 2009). VMC applications like video conferencing and video chat have been used increasingly to connect to extended family members and close friends who are separated by long distances and the potential of this technology has received a great deal of media attention (e.g., Harmon 2008). It has been found that VMC can allow family members and friends to feel more connected, and also enable them to share activities with each other in real time (Kirk et al. 2010; Ames et al. 2010; Judge et al. 2011; Judge et al. 2010). When asked what they meant by feeling "close", participants in the Kirk et al. (2010) study expressed that video helped people know each other better, such as children and their grandparents. It also enables young children to converse more effectively than they can over the telephone. Additionally, people desired video because they wanted to be involved in their family's or friends' ongoing lives, take part in routine activities, and just know that someone is there.

Being able to enhance the feeling of "being there" is one key potential of video communication. Researchers have explored young children's interaction with video communication to see if it could provide similar benefits to having their parent be there physically (Tarasuik et al. 2011). The results of this work demonstrated that young children connecting with their parents over video had similar effects as when the parents were physically present, such as exhibiting a similar level of interactivity in both the video and in-person conditions.

Examining children's use of VMC with adults, several studies have found that synchronous VMC has great potential to help young children and adults feel connected. For example, Ballagas et al. (2009) suggested video-mediated communication may be particularly appropriate for communication with young children because it provides better resources for grounding conversation and supports playfulness in remote communication. Ames et al. (2010) compared young children's use of phones and synchronous video conferencing systems to interact with adults. These children enjoyed video chat more than telephone conversations, and were more engaged with video, which led to longer and richer communication. Also, the visual medium enabled activities that would not have been possible with the phone and the children were able to have different levels of participation in the conversation.

In a study of work-separated families Yarosh and Abowd (2011) also found that in some families video chat was an effective way for children (age 7–13) to stay in touch with a remote parent. Their participants reported that video was more emotionally expressive than phone conversations which led to longer conversations and allowed children to engage in show and tell. Unfortunately, participants also reported barriers that limited their ability to use video: problems with setup overhead, lack of necessary infrastructure such as a computer or reliable connection, and the requirement for dedicated time without being able to multi-task (e.g., washing the dishes while talking on the phone). A few families also used online gaming to maintain contact while apart, but several challenges were encountered including lack of support for multiple players on the same computer (so multiple kids could play with the remote parent), difficulty keeping younger children involved in games, and some children's lack of interest in playing with their parents.

Several researchers have looked at ways of extending video conferencing technology to better support children's play with remote adults. For example, Follmer et al. (2010) explored four design approaches for shared play activities to support family togetherness. These activities involved games and book reading activities in a system called Video Play which augmented traditional videoconferencing. Results from initial trials demonstrated that the activities were engaging to both young children (ages 1–7) and their parents, but that some scaffolding was necessary. One concept from this work, Story Places, was found to be a particularly compelling activity for children to engage in with distant family members. In follow-up work Ballagas et al. (2010) explored a distributed interactive book-reading system to improve the feeling of connectedness for long-distance families. Further studies of this system (renamed StoryVisit) revealed that young children were more engaged in video-chat sessions when an e-book was incorporated (Raffle et al. 2011a, b).

Most video communication technologies have been primarily designed to support conversations, however, families often want to incorporate physical artifacts into their play. Researchers have begun exploring technologies that enable physical objects to be incorporated into play between children and a remote parent. For example, the Virtual Box project (Davis et al. 2007) explored asynchronous remote play by allowing a parent to place a virtual gift box on the floor plan of the child's home that the child could later try to find with the aid of a location sensitive PDA. Yarosh et al. (2009) studied parent-child pairs playing a board game together in a media space that included face-to-face video and a shared tabletop video task space. They found that parents and children were able to socially negotiate rules and access to the physical artifacts in the remote space.

In summary, VMC shows a lot of promise for connecting children with adults since video can support rich cross-generational play. Additionally, children's sense of connection comes more from play than discussion. This suggests that video could be beneficial to support children's remote play with their peers.

Synchronous Video to Support Children's Remote Play

Free play is characterized as an unconstrained activity in which children initiate and direct their own interaction with each other and their environment (Johnson et al. 1987). Time spent in free play is a critical part of a child's cognitive development (Vygotsky 1966) and to developing sociocultural and emotional competencies between infancy and adolescence (Stafford 2004).

Social scientists have been exploring children's play for many decades, from the early investigations of Vygotsky (1966) and Piaget (1926) to the current work of the National Institute for Play (2009). The National Institute for Play identifies seven patterns that constitute the elements of play: (1) attunement play (the interplay of affective feedback such as returning a smile); (2) body play; (3) object play; (4) social play; (5) pretend play; (6) narrative play; and (7) transformative-integrative play. These elements are often combined during free play episodes.

Parten (1932) and Howes (1980) observed that social play between children is characterized by five stages of mutual regard and reciprocity. At the most basic level, children participate in parallel play—activities in proximity to one another, but without engaging in social behavior. At higher stages, children direct social behaviors to one another and respond to the behaviors of their play partners. At the highest level of social play, children engage in a complementary and reciprocal activity that requires both verbal and non-verbal coordination on their parts. During free play children may frequently switch between various types of social play.

There has been research on playing games over synchronous video such as Batcheller et al.'s work (2007) which observed groups of college students playing the social game "Mafia" mediated by a videoconference. They found that playing over videoconferencing was fun for participants, but introduced new challenges in terms of managing attention, signaling to remote partners, and social distance. In other work Mueller et al. (2003) examined a class of prototypes called exertion interfaces which combine projection of full body video and computer vision techniques to allow remote partners to play sport-like games together. They discovered that exertion interfaces have a great potential to create and strengthen social bonds between adult strangers. All of these investigations however asked participants to play games with pre-established rules rather than free play over a videoconference.

The next sections describe two recent projects that used VMC to support children playing with remote friends: Video Playdate and IllumiShare.

Video Playdate: Supporting Children's Free Play with Video

To understand the challenges and opportunities that video can provide for free play Yarosh et al. (2010) first studied children playing together using toys such as action figures and dolls with a standard videoconferencing client (Windows Live Messenger) using two different setups: laptop to laptop; and large screen TV to large screen TV. This preliminary study indicated that free play was possible over videoconferencing, but was limited to short periods of social play interweaved with longer periods of parallel play. Examples of social play included pretending to be TV characters, singing a song together, role playing using dolls, and narrating a scenario using action figures. When using either the laptop or TV, the children struggled to understand several communication asymmetries that videoconferencing presents. For example, children (as well as adults) have a difficult time understanding the field of view of the web camera, and therefore do not always know what is visible to their friend. Additionally, the children did not have a good awareness of appropriate volume levels and had a tendency to talk very loudly. This seemed to be influenced by the fact that their friends looked like they were far away, and therefore they believed that it was necessary to talk loud (or yell) to be heard. The children also had trouble seeing each other's toys clearly.

Comparing the laptop and TV conditions, the researchers observed that the children could understand each other better and paid more attention to their friends in the laptop condition, however, they also had to remain relatively immobile in front of the screen. In the TV setup, the children took the opportunity to move around the space more freely but they were troubled by the amount of pixilation of the video. The TV condition also introduced too much physical distance between the children, causing the children to walk right up to the screen to try and get closer to their friend (see Fig. 6.1).

As a follow-up to this work, Yarosh et al. (2010) investigated four different videoconferencing prototypes, each with different affordances for controlling the

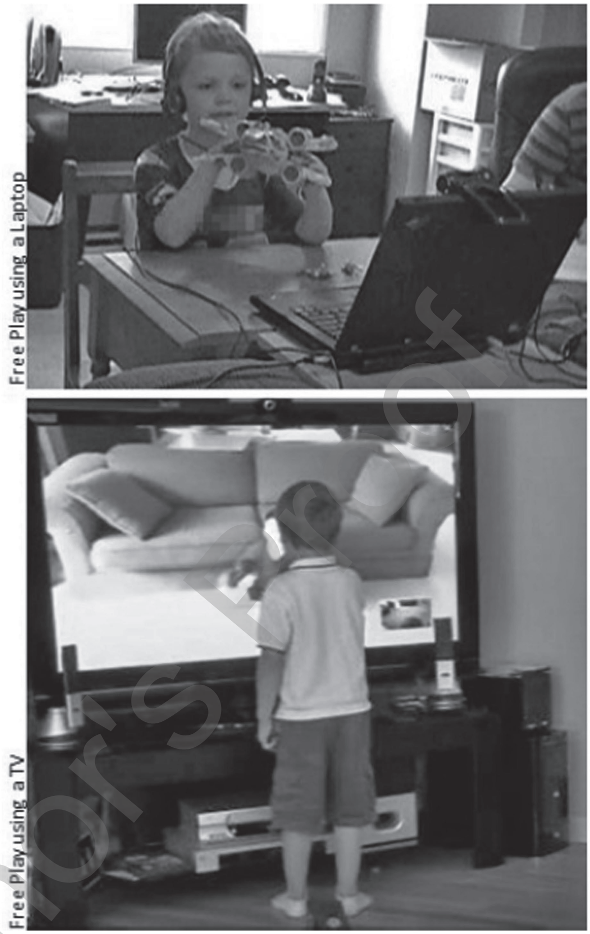


Fig. 6.1 Children playing together via videoconferencing using either laptops or large screen TVs

children's view (see Fig. 6.2). The following sections describe each of the prototypes as well as the strengths and weaknesses of each as observed during a user study.

Vanilla Prototype

The Vanilla prototype simulated a high-resolution low-latency videoconference. Figure 6.2a shows the setup including a high resolution webcam (1,280 × 1,024), microphone and 24″ display of the remote video stream. The smaller screen on the right echoed the image currently being sent to the remote participant. Despite the fact that the basic feature set of this condition was similar to the commercial systems used in the first study, the Vanilla condition was quite effective and the children were engaged while playing in this condition. This prototype was rated

Fig. 6.2 Four video conferencing prototypes tested in the Video Playdate research. **a** *Vanilla prototype*. The small screen shows what the remote participant sees. **b** *Mobile prototype*. Unlocking the small screen activates the camera on the back of the device, allowing the child to control the remote participant's view. **c** *Smart Pan-Tilt-Zoom prototype*. A researcher controls the pan-tilt-zoom camera (*red box*), allowing the child to request different remote views. **d** *Play Rug prototype*. A floor mat is used as the projection surface for a monochrome view of the remote participant's rug

easiest to use, however, visibility was still a problem and the children sometimes had difficulty making sure that their toys were visible to their friends.

Mobile Prototype

The mobile prototype gave the children the ability to control their friend's view with a simple mobile video device (see Fig. 6.2b). The mobile screen consisted of a 7″ monitor with a standard webcam attached to the back, facing away from the viewer.

When the mobile device was picked up, the camera on the back of the device was activated and the child could point it at anything in their environment they wanted to show their friend.

Again, the children were able to easily play with each other using this prototype, however, many of the children considered it to be the most difficult since they had to hold the device while composing their shots. Additionally, when the mobile component was activated, it replaced the face-to-face view which sometimes made it hard for their partner to understand what they were trying to do. The children that used the mobile condition successfully often used a turn-taking strategy to be able to play together ("*first I show my doll, then you show your doll*"). Despite the challenges it presented, several children found the mobile condition to be very compelling and some commented that "*you could literally be where the person was playing!*" Most of the children selected this condition as the most fun and it tied with one of the other conditions for being the most desired condition.

Smart Pan-Tilt-Zoom Prototype

The Smart Pan-Tilt-Zoom (PTZ) prototype used a PTZ camera with a Wizard-of-Oz methodology where the researchers controlled the PTZ camera (see Fig. 6.2c). The children could direct the PTZ camera by giving a verbal command to specify an area of interest, such as ("*zoom in on the toy car*"). If the children did not provide any direction, the researcher manipulated the PTZ camera to keep the children in view as much as possible.

This prototype enabled the children to move freely about the space, have a clear view of their partner, and also be able to focus on the toys when appropriate. Some of the children liked that the camera automatically chose the appropriate view while others enjoyed being able to easily control their view. At times the children had trouble negotiating who should control the view and had to resolve this conflict socially (e.g., "*okay, ask yours to zoom in on the* [toy]") or through planned sequences of views ("*so start out so we can't see them, and then we go here, and then ta-ta-da!*"). They also sometimes wanted to keep an object (or themselves) hidden. For example, some children expressed "*don't look here, I want to do a surprise*". One negative aspect of this prototype was that the movement of the PTZ camera was sometimes distracting and some children became disengaged from the session and instead played "dodge-the-camera".

Play Rug

The Play Rug prototype used a camera-projector system to provide a shared floor space for the children to play on. A camera suspended above the play rug (see Fig. 6.2d) captured a video stream of the rug surface and transmitted it to the remote projector. The video stream of the remote floor space was projected directly on top of the local floor space and vice versa. Like the PlayTogether system (Wilson and

Robbins 2007), the visual echo problem (i.e., re-projecting artifacts) was resolved by installing IR filters on the overhead cameras. This restricted the video to be only monochrome, but allowed a standard rug to be used rather than a specialized projection surface.

The children saw potential in this technology and often selected it as the one they would most want to have at home. However, there were several challenges with the prototype. First, it was hard for some children to understand the interweaving of the two physical spaces and some were confused when a physical and a virtual object occupied the same space. Additionally, while being able to occupy the same space allowed for some fun physical play (in fact, this condition had the most movement play), this feature also made it difficult for some children to come to an agreement about the interaction between physical toys. For example, two of the children playing with cars could not agree on an interpretation of events ("*It's rolling over you!*" "*No, it's rolling under me!*"). Finally, the monochrome projection of the remote activity was often too subtle to attract attention and it was hard for the children to see both the screen and the rug at the same time. This led to some missed opportunities for social play.

Overall Feedback Across the Conditions

Overall, although there was a great deal of individual variability, the children were able to successfully play together using all of the prototypes. Though all four prototypes supported social play equally well, different technologies for managing views led to different types of play among the pairs. The shared task space created in the Play Rug setup supported movement and physical activities, such as play fighting and tumbling. The Mobile setup enabled the children to control their partner's view and encouraged turn-taking and narrative play. However, when view control was simplified in the Vanilla and Play Rug setups, the children could devote more cognitive resources to engaging in pretend play. It is also important to examine whether technology should be designed to support natural play, or add to the experience. Aspects of both the Play Rug and the Mobile setups became a part of the children's play instead of just enabling play.

The results from this project demonstrate the potential of supporting children's free play through video, but also highlights challenges that exist for many videoconferencing environments. We briefly present these opportunities and challenges which helped inform the design guidelines presented later in the chapter.

The first challenge deals with managing the visibility (and invisibility) of objects and toys in the space. This includes problems related to resolution and framing play within the camera view. Interestingly, several of the children used the cushions around the play area to establish a stage for their toys that they knew was clearly visible to the other person.

A second challenge stemmed from the lack of peripheral cues, and the fact that children frequently shift attention between individual and mutual activities during free play. For children, a face-to-face view of their partner was key to their social

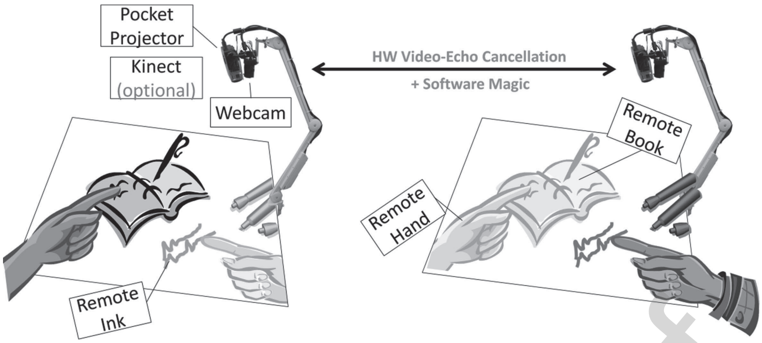


Fig. 6.3 Illustration of table sharing with IllumiShare

play as it was the only reliable clue to the direction of their partner's attention. Seeing their partner attend to their activity led to greater social play, while perception of inattention led the children to play in parallel instead. Managing attention also became more complicated with multiple displays. Elegant view management that both signals the direction of the partner's attention and lets the child appropriately direct their attention is an open challenge for designers.

A third challenge involves helping the children manage intersubjectivity. Intersubjectivity is defined as the capacity for establishing and maintaining a common ground of engagement among participants involved in an activity together (Winegar and Valsiner 1992). In the context of video-mediated play it involves understanding both what you and your partner see and determining how to act meaningfully towards each other. However, play is a cognitively demanding activity that leaves few attention resources available for maintaining a mental model of what the other person sees. Children who were most successful at framing their play made frequent use of the feedback screen, but many still seemed to get confused about who sees what.

IllumiShare: Providing a Shared Physical Task Space

Having children be able to easily see and interact with each other's toys is an important part of their play. As shown in the previous section, visibility of toys and children's actions with the toys is often challenging in typical video conferencing environments. Yarosh and Abowd explored this concept for children's interactions with remote adults and developed a system called ShareTable which allows children and their parents to have a shared view of physical artifacts (Yarosh et al. 2009). Junuzovic et al. (2012) designed and built a similar system called IllumiShare which is a cost-effective, light-weight device that enables users to share physical and digital objects on *any* surface while also providing rich referential awareness (see Fig. 6.3). Although IllumiShare is similar to previous devices (e.g., Clearboard, Ishii and Kobayashi 1992; VideoDraw, Tang and Minneman 1991; PlayTogether, Wilson and Robbins 2007; ShareTable, Yarosh et al. 2009) it enables any surface to be shared, and provides a better quality view of the remote shared space.

IllumiShare enables children to interact with objects in a natural, seamless way, similar to how they would interact in a face-to-face environment, however, their interactions are bounded by the constraints of the system in terms of what can and can't be seen. IllumiShare has a simple affordance—anything in the illuminated area is shared with others. For example, children can draw together on a piece of paper simply by placing the paper underneath IllumiShare. From that point on, they can draw together right on the paper and also see each other's hands as they point at parts of the drawing.

Use of IllumiShare can be combined with a standard videoconferencing session to provide the children with both a face-to-face view of their friend and the shared surface. This is similar to the setup used by Tang et al. (2010) which explored the benefits of providing support for the person-, task- and reference-spaces. Orientation of the shared surface is an issue for all surface sharing systems. Similar to ShareTable, IllumiShare orients the surface in the same direction for both children. This means that the children's hands and arms come out from the same side of the table, as if the children were sitting in the same chair. This also means that the remote-child's hands and arms are disembodied from their front-on view, which is seen across the table. However, consistent with previous research (Tang et al. 2010) the children had no trouble understanding this configuration, and were able to interact naturally.

Junuzovic et al. (2012), studied eight pairs of children (ages 9–11) using IllumiShare during remote play. IllumiShare was combined with a Skype videoconferencing session to support both face-to-face interaction and task-based interaction (see Fig. 6.4). Children played in three different conditions: IllumiShare-only, Video-only; and combined Video+IllumiShare. Audio was provided in all three setups.

The children's play during the IllumiShare sessions was extremely intuitive and the system encouraged natural interaction. They immediately understood the IllumiShare semantics that anything that was lit up by the projector was shared (public) and everything else was private. All of the children understood that if they pointed in the illuminated area, their friend could see their hand, as well as where they were pointing. Interestingly, if a game could not be played remotely with its original rules, the children easily modified the rules.

Overall, the children engaged in 40 different tasks during the play sessions which were clustered into five categories: pen and paper (20); card or dice games (8), showing things (4); gesture games (3); and other games (4). Figure 6.5 shows screenshots from some of the activities. Pen and paper activities consisted of activities such as drawing and writing. Example card or dice games were War or Bowling. Showing things typically involved showing books or magazines. Gesture games were rock/paper/scissors and dancing. The other games included I Spy and Mancala. The pen and paper, as well as dice and card tasks were predominantly performed when IllumiShare was available while gesture games were played when Video was

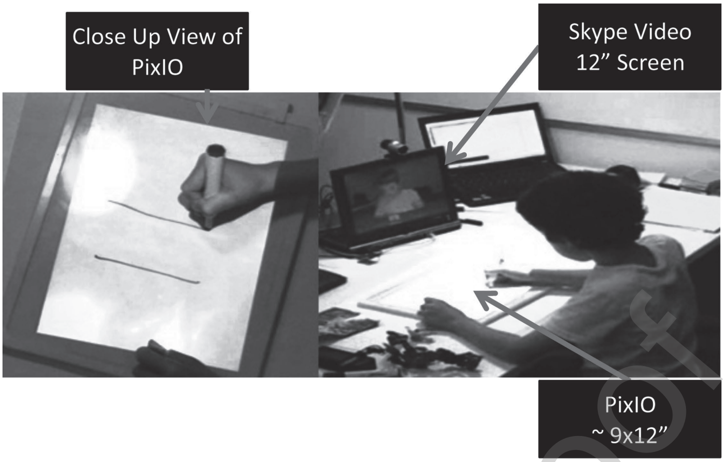


Fig. 6.4 Experimental setup for the IllumiShare user study, which included both Skype video and IllumiShare

Fig. 6.5 Screen shots of children doing various activities with IllumiShare

available. The other games and showing things were mostly performed when both IllumiShare and Video were available.

Video+IllumiShare

The children seemed to thrive in the Video+IllumiShare setup. In all groups, the children were fully engaged as soon as the session started. Often, the first reaction to having both IllumiShare and Video was to write a quick note in the shared area. They also interacted using toys, such as fighting with action figures and arranging toys in playful ways. The children were very animated about what they were doing, even if the task was taking place on the shared surface. For instance, when a pair of boys was playing the card game War, one of them used whole body gestures and as he put cards down. He would say things like "*I summon…an ace!*" in an authoritative wizard like voice as he slammed his card down on the table. Meanwhile, when a group of girls played I Spy, each of them had a copy of the board and when one found an item, she would get extremely excited, put the board into the shared area and point at the item's location. The other would immediately look at the remote board where her friend's hand was pointing in order to find that same location on her own board.

The Video+IllumiShare condition was considered the easiest and most fun. The children explained that it was "*just like being next to them*". When asked which setup they would like to have at home, all but one selected Video+IllumiShare, because "*you can see each other and play on the table*", and "*because you can see the person and see what they are doing*".

Video-Only

When the children had Video but not IllumiShare (i.e., standard video conferencing setup), they seemed to struggle more to play compared to the other conditions. Some were able to adapt quickly, for instance, a pair of girls played I Spy but had to bring the I Spy board up to the camera to point at a location. In other cases the video condition resulted in awkward silence during which the children would glance around the room and look at each other without talking. In one such instance, the silence was broken with "*Oh look, scissors. I can't wait until the table thing works*". Most children ranked the Video condition as being less fun than IllumiShare because "*just video was more of a talk thing. If you wanted to just talk, you would be fine. But if you wanted to play, then video wasn't good*".

IllumiShare-Only

Children performed similar tasks in the IllumiShare and Video+IllumiShare conditions, but they tended to be less visually animated without the video. For instance, the same pair of boys whose game of War was described earlier also played War without the video. In this case, all of the body actions, such as hand motions, were subdued and took place on the shared surface. The absence of video was most noticeable when the children had difficulty interpreting what their friend was doing (for example, if they were not doing anything on the shared task space). In these instances the children would often called out to see if the other person was there and ask what they were doing.

Overall Feedback Across Conditions

IllumiShare had a significant impact on the children's level of engagement during their play. When IllumiShare was removed, engagement decreased while adding IllumiShare back increased engagement. Some children struggled to find something to do without IllumiShare. For example, one girl asked her friend "*What can we do over video chat*" and her friend responded "*I don't know*". The children sometimes reacted negatively to the removal of IllumiShare "*This is bad! This is very, very bad!*" and were excited when it was brought back, "*Oh good*" to "*Yaaaaaay, Table!*" In contrast, the removal or addition of video had little impact on level of engagement.

Overall, combining IllumiShare and Video was extremely compelling in terms of supporting children's remote play. The children's interactions were seamless and natural and the children enjoyed playing together using these technologies.

Playing Together with Asynchronous Video

Although synchronous video is an effective way to connect children with their peers, there are several challenges as well. One of the biggest obstacles is the fact that synchronous video requires both children to be available at the same time. This is problematic for two reasons. First, families are busy and schedules can make it hard to coordinate times for children to connect. This was observed by Modlitba and Schmandt (2008) who studied children's interactions with travelling parents and found that although children prefer using video chat, their parents' busy schedules made it hard to coordinate synchronous video chats. Second, children often do not have any awareness of when their friends are available to connect over video. Unlike the workplace where people spend many hours sitting in front of their computers, children's use of computers in the home tends to be for short periods of time, and can be sporadic. Without having some sort of explicit coordination, it is easy to imagine children missing out on opportunities to connect with their friends.

Using asynchronous video as a more flexible means of connecting families was proposed in work by Cao et al. (2010). In other work, Zuckerman and Maes (2005) proposed the Contextual Asynchronous System (CASY), which enabled family members to send 'good morning' and 'good night' asynchronous video snippets into a shared family database. The recipient could then view the snippet in the context of going to sleep or waking up. An initial prototype of this system found that the asynchronous video snippets increased participants' feeling of connectedness.

Raffle et al. (2011a, b) explored the viability of asynchronous photographic and video messaging for pre-school aged children to communicate with distant relatives. They developed three innovative prototypes that explored a jack-in-the box toy with an embedded mobile phone to enable children to compose and share electronic media. The prototypes work by placing a mobile phone into the Toaster prototype and pressing down which causes the phone to start playing the Pop Goes the Weasel song. While depressed, the phone can take a photo, cue up a video, or display an image on the screen. When the song is done, the phone pops up and displays the media to child. The children's images or performances with the device are automatically captured by the front-facing camera on the phone, and are then shared with remote family members. The *Orange Toaster* took photos of the children; the *Family Toast* device enabled children to use tangible objects to select and browse family photos; and the *Play with Elmo* prototype played videos created by a remote

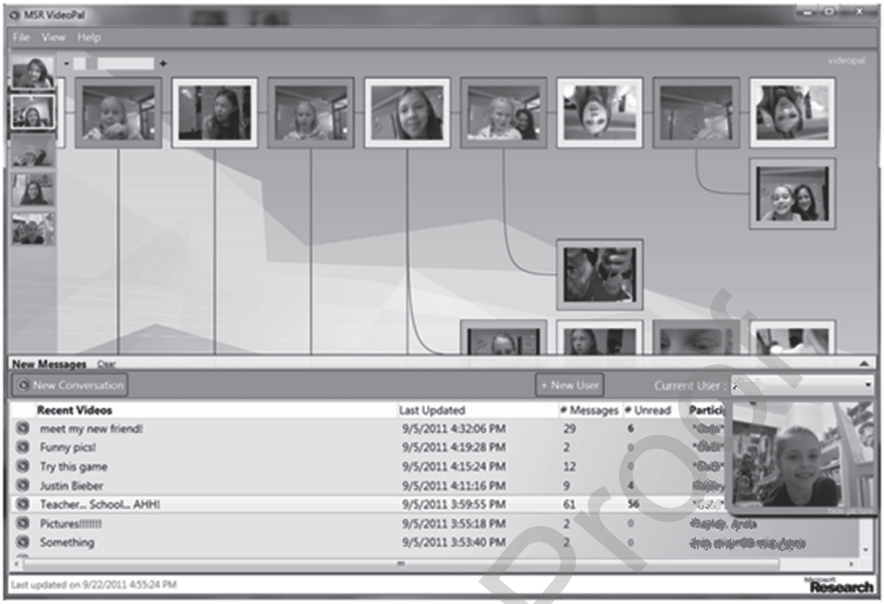


Fig. 6.6 VideoPal screen shot. The *bottom* half of the screen displays a list of active video conversations and meta-data about those conversations. The *top* part of the screen shows a visualization for one of the conversations

family member. Although the communication aspects of these prototypes have not been extensively studied, this work shows potential for asynchronous messaging to support young children's interactions.

The next section describes recent work exploring children's use of VideoPal, an asynchronous video messaging system to support children's communication with their friends.

VideoPal

VideoPal is an asynchronous video mediated communication tool designed to enable children to easily exchange video messages with their friends to engage in a rich conversation. VideoPal captures video using either a webcam, recording the screen (with or without a voice overlay), or uploading an existing video. Video messages can be sent to one or more friends and are organized by conversation topic to show the flow of a conversation, indicating who responded to whom and when (see Figs. 6.6 and 6.7).

VideoPal was initially used as an educational Pen Pal tool to support the development of cross-cultural friendships (Du et al. 2011). Thirty, 9–12 year old children (15 girls, 15 boys) from the United States and Greece corresponded with each

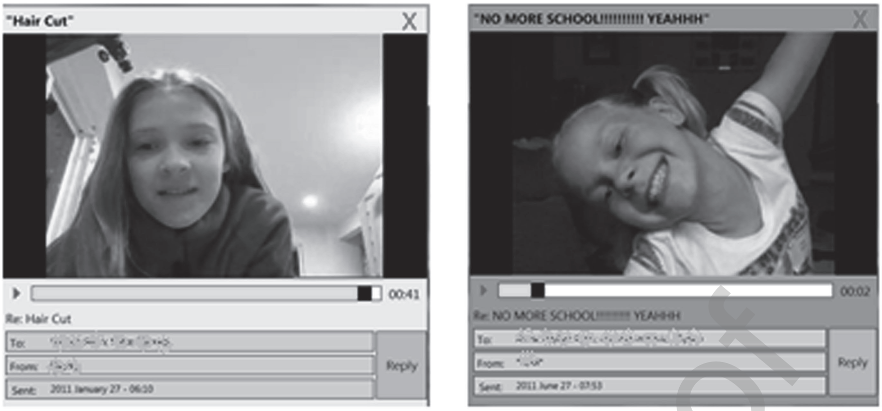


Fig. 6.7 User Interface to enable children to play and reply to video messages

other using both Email and VideoPal. Results from this work demonstrated that the children preferred VideoPal over Email because it was more fun, it enabled them to get to know each other better, and made them feel closer to their new friends. Furthermore, the children liked VideoPal because it enabled natural communication including speech, body language and facial expressions. These results are consistent with media richness (Daft and Lengel 1984) and social presence (Short et al. 1976) theories and demonstrate that the benefits of synchronous video communication can also be realized with asynchronous video.

VideoPal was also used to examine how asynchronous video could augment children's existing friendships (Inkpen et al. 2012). Just as text messaging has become an important part of youth's social communication (Rideout et al. 2010) video can provide even more richness and enable children to interact with each other in new ways. A 9-week field study was conducted with a group of six girls who used VideoPal in their own homes. The girls, age 9–11, were very close friends and saw each other almost daily.

The girls' usage of VideoPal was overwhelming. Within the first 24 h (which occurred during the girls' school holiday) the girls sent each other 197 video messages. Within the first 2 weeks of the study, 585 messages were exchanged in 93 different conversations. Most of the messages were webcam messages (90 %), and most were sent to all of the girls in the group (60 %). The length of the conversations varied widely, with some conversations only having one message, and others having upwards of 140 messages. Most of the messages were relatively short, with 75 % of them being less than 30 sec. long. Besides just creating messages, the girls received a lot of enjoyment from watching their friends' video messages (as well as their own). During the first 2 weeks of the study, there were 2,670 message views and some messages were viewed upwards of 36 times. When asked what they liked best about VideoPal their responses included because you can "*see your friends*", "*being able to chat with your friends when they are not with you*", "*see people's videos even if they're not online*", and "*send videos when other people aren't on the computer*".

Although VideoPal was designed as a conversation tool, it was used for much more than just talking. The breadth of use was fascinating and included many types of sharing and play. The videos were coded and clustered into six different genres: conversations; show and tell; sharing activities; screen recording; play acting/performing; and just for fun. The next sections describe each of these genres to show the power video has to connect close friends. Figure 6.8 gives an illustrative example for each genre.

Conversations

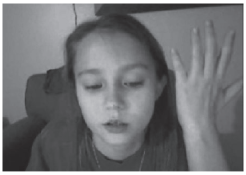
Despite the fact that all conversations were asynchronous, there were many videos where the girls would just turn the webcam on and talk to their friends, even though their friends were not actually there. The girls were very comfortable talking over video, and the videos seemed fairly spontaneous, and not rehearsed or planned. The dialog was very conversational as the girls addressed each other, and responded to each other's comments. Many of the conversation videos were normal, everyday exchanges about the things going on in their lives, like homework and what they were doing. Often, the girls' behaviour in the videos seemed as if they were actually talking to their friends face-to-face. They also took advantage of the visual nature of the video medium to aid the conversation when needed.

Show and Tell

The girls liked to create videos to show each other things such as their favourite Christmas presents, their pets, their rock collections, and tours of their rooms. The girls used the mobility of the laptop to walk around their homes and share many different things and they would often show themselves along with the artifacts they were sharing. These show and tell activities were sometimes challenging however, because of problems capturing the artifacts. For example, walking with the camera resulted in too much movement, causing the video to be very jumpy and difficult to watch. It was also awkward to walk around carrying the laptop in one hand, and using the other hand to point the webcam at the items of interest. And even if the girls were more stationary, it was sometimes difficult to position the web camera appropriately to capture the desired scene.

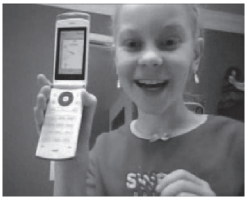
Sharing Activities

Often the girls wanted to be able to share the activities they were currently engaged in, even if their friends were not available. This is consistent with Judge and Neustaedter's (2010) work on video conferencing in the home which demonstrated that families with children primarily used video conferencing to share activities instead of just conversations. For example, the girls created videos of themselves playing



A. Conversation

"Hey Miki, guess what I had for dinner today, CEREAL! ... I had Lucky Charms ..."
"Um, you always have cereal Hannah, I am like so not surprised ..."
"Miki, you are right, I ALWAYS have cereal ..."



B. Show and Tell

(singing) "I got something awesome ... A PHONE! .... It's my own phone! Do you want to see some pictures on it?"

C. Shared Experiences

"Ok guys. I am going to show you my made up beam routine."

D. Screen Recording

"Hi guys, this is my slide show of Funny Bunnies. So right here is a picture of a bunny popping out of an Easter egg ... "

E. Play Acting / Performing

Lady Gaga & Beyonce. Telephone Music Video.

F. Just for Fun

"Watch us roll in our money. WHOOO! <lots of screaming and laughing>"

Fig. 6.8 Example video messages for each of the conversation genres things like Xbox Kinect, doing gymnastics, and building a playhouse. Sharing activities was quite different than conversations, because they tended to capture larger spaces, such as a whole room, or a full-body view. This was somewhat problematic because today's web cameras are optimized for up-close interaction and typically do not have appropriate zoom levels. Additionally, being able to see the feedback window from a distance was hard, so it was difficult to know what was in view of the camera. Finally, when sharing activities, the girls often moved around a lot, again, making it difficult for the camera to capture.

Screen Recording Videos

Although the screen recording feature was only used 10 % of the time, all of the girls commented that they enjoyed making screen recording videos and liked having this feature. Common uses of the screen recording feature involved narrating slideshows and poems, showing excerpts from online games, and showing YouTube videos. Overall, the girls expressed that this was an important feature in the system and that they liked to be able to share things happening on their screen. However, the user interface for this feature was a little awkward to use, which may have impacted the overall use. The voice overlay feature was also important and was used extensively as almost every screen recording had an associated voice overlay. One of the girls was able to carefully arrange her windows to provide a picture-in-picture experience, showing her face, actions, and gestures along with the screen recording. Several of the girls wanted to be able to create these picture-in-picture style videos.

Play Acting/Performing

There were many videos where the sole purpose was to perform instead of converse. The girls acted out things like scenes from Harry Potter or created lip-synced music videos. To add theatrical effects the girls often used props and sometimes moved in and out of the view of the camera. Some of these videos are similar to the types of things children like to share on YouTube; however, VideoPal enabled them to share their videos securely, with just their close friends. Additionally, instead of being a stand-alone YouTube video, they were often part of a conversation thread, where their friends could provide video replies.

In some of the play acting conversations, the girls' play would follow on from one another, which was refered to as asynchronous play. Similar to how children build off of each other's play activities when face-to-face, there were several conversations where one girl would do something, and others would follow along without any explicit coordination. For example, several girls added videos to a Harry Potter conversation where they each acted out different scenes. This created a storytelling style of play, similar to the types of interactions reported for StoryMat (Cassell and Ryokai 2001).

Just for Fun Videos

Often when children get together face-to-face, they like to do crazy things, just for fun. Many of the girls' conversations fit this characterization. Ludic actions that had no specific purpose, other than to share something fun with their friends such as two girls rolling in play money, a girl throwing candies up in the air and catching them in her mouth, and girls making faces in the camera. VideoPal enabled the girls to do silly things to make their friends laugh, even though their friends wouldn't see the video until later. The girls commented that these types of activities were fun when they were at home alone, and were bored. The girls were also observed creating these types of videos when they were physically together with their friends to support their copresent play, although they still enjoyed posting them on VideoPal to share with the rest of the group.

Summary

This research clearly demonstrates that asynchronous videos can support rich conversations, and that it is an effective way for children to connect with their friends, even when their friends are not available. Video adds richness to the communication not possible in current text media. The standard use of smiley faces and emoticons in text-based communication pales in comparison to the expressiveness in the girls' facial expressions, actions, gestures, and voices. Children have no trouble conversing over asynchronous video and these exchanges can be as natural as face-to-face interactions. Additionally, asynchronous video is beneficial for more than just conversations and can enable children to share many different types of experiences with their friends.

Both boys and girls were equally enthusiastic about VideoPal in the school study and both enjoyed sending and receiving videos. However, it is important to note that the more in-depth, 9-week study only involved girls' use of VideoPal. Although the school data indicates that boys are interested in asynchronous video messaging, it is possible that their use of the system and the content they would share could be quite different than what was observed with the girls. More research is needed to better understand how other factors such as gender and age impact children's use of video when communicating with their friends.

Design Recommendations

Examining results from this body of work provides several guidelines for video-based systems to connect children and support their rich social play.

Camera Control and Framing

For both synchronous and asynchronous video communication, one of the biggest challenges is capturing an appropriate view from the camera. This especially problematic for children's play given how much they move around while playing and the fact that they often want to share a large play area. One possible solution is to provide some automatic, or user-guided camera control, where the children can specify what should be in view of the camera, and then have the camera automatically capture the scene by tracking objects or people and panning, zooming, and cropping accordingly. The objects being tracked could be the children themselves, the toys they are playing with, or other markers in the scene that children use to delineate an area. Although there were some concerns with the automatic camera approach in the Video Playdate study, this method would give the children more control over what is captured, and what the camera follows.

A second tension surrounding camera control and framing is ensuring that the children maintain an awareness of what is being captured and shared with their friends. If markers are being placed in the scene as suggested above, this could provide cues to the children about what is visible (as well as what is not visible). However, if the camera is performing more complex pan and zoom operations, some sort of feedback window will be necessary to show what the camera is capturing. Ideally, this feedback window should be positioned in such a way that it is easy for the children to see and does not distract from their activities. For example, the current design of IllumiShare provides a natural affordance of what is being shared given that the projector illuminates the shared space, making it easy for the children to understand what their friends can see (anything placed in the illuminated area), and cannot see (anything outside the illuminated area).

Multiple Camera Streams

Many synchronous video conferencing applications are moving towards transmission of multiple video streams to support group-based videoconferencing. Support for children's play will also benefit greatly from capture and transmission of multiple camera streams. Depending on the type of play, children often want to show their own image, as well as toys or artifacts in their environment, or a screen recording of a game or virtual world they are playing in. Providing multiple video streams enables children to share richer context. Previous work by Gaver et al. (1993) also suggested that three types of views (face-to-face video, task space video, and room context video) were useful, but that switching between video views was challenging because it undermined a person's ability to know what their remote partner was looking at or could see at any one time. Multiple video streams could also be used to better facilitate group play, but the design of the system would need to attend to the issue of intersubjectivity and the ability for each person in the group to know what the others are seeing.

Mobility

As evidenced in much of the previous work, mobility is important for children's play. This is consistent with the results from Judge and Neustaedter's research on video conferencing in the home (2010) which showed that families with laptops would move them around to share activities from different locations in the home. Children's play is rarely restricted to one specific location, and even during play, children may move from place to place. As such, technology to facilitate children's play should be flexible enough to support mobility. Laptop computers and tablets provide some mobility for video conferencing by enabling children to take the device into any room in their home, however, the form factor still makes it awkward to carry from place to place, and movement during play is problematic often resulting in jumpy video that is difficult to follow.

The form factor of a mobile phone may be better for scenarios where mobility is important, particularly when capturing video outside of the home. However, while mobile phones are more conducive to moving around, the small screen may be restricting to the children's experience. First, it would be hard to see the friends they are playing with, as well as get feedback on the video they are sharing. Second, the mobile phone often needs to be held, making hands-free use difficult. Future work exploring different form factors for video capture and playback de-vices is needed to better understand ways to enable mobility while still providing a rich, engaging experience for the children.

Blur Temporal Boundaries

Synchronous video enables children to connect in a rich, face-to-face-like manner, however, scheduling and coordination can be a problem. Asynchronous video helps overcome these issues and enables children to connect with their friends at any time. In the VideoPal studies, some of the messages were exchanged when the children were online at the same time, and as such, these messages were more analogous to rapid-asynchronous exchanges (i.e., when all parties are online at the same time and messages are exchanges in a more synchronous manner). In these situations, the children would often prefer to connect using synchronous video. We see potential for both synchronous and asynchronous video to support children's play, and ultimately, a system that enables seamless shifting between synchronous and asynchronous modes of video communication could provide the best of both worlds.

Ease of Use Critical

A critical issue for video communication systems is ease of use. Too many existing video communication systems require substantial overhead to setup a video call or require that all users have the same software system. This limits how frequently people will choose to utilize the system, as well as whom they are able to talk to. One of the successes of the VideoPal system was how easy it was for the children to use. Although, a great deal of the functionality in VideoPal exists in other software (e.g., video messages can be recorded using webcam software and attached to an email message), VideoPal streamlined the process and made it very easy for children to use. This helped encourage extensive use of the system.

Privacy & Security

Sharing videos publically or with a group of friends has become commonplace with systems such as YouTube, Vimeo and Facebook (Moore 2011). However, many of these videos are broadcast in nature and don't reflect a back-and-forth conversation. Using video for a conversation, or to play with friends is a more personal exchange, and as such, privacy and security issues are important. If the goal is to support children's play, privacy and security becomes extremely important to ensure that the videos are only available for the intended audience, and that the children's safety is ensured. Appropriate parental controls and monitoring must be provided.

Another challenge for video communication in the home is the fact that several different family members may be using the same system to communicate with different people. However, unlike office scenarios, family members are often comfortable with a higher level of sharing, and prefer fast, easy access instead of cumbersome log-off/long-on procedures. A more nuanced approach to family accounts is likely needed to support individual and family video communication (Egelman et al. 2008).

Video Search

Although video is an extremely rich communication medium, it can be difficult to index and search. For example, the VideoPal system uses one frame of the video as a thumbnail for the message; however, because many of the videos start out as a "talking-head" video, most of the thumbnails look alike. This makes it very difficult to find a particular video. One possible alternative is to use speech-to-text systems to automatically record the words spoken, and enable users to search the transcripts. Although this is feasible in theory, it is extremely difficult to do in the context of children's play since children's voices are challenging for automatic transcription (Potamianos 2003). Additionally, the expressiveness of the children's voices (e.g., excitement, enthusiasm) makes this problem even more complex. More work is needed to provide better ways to index and search video content.

Social Networking

The asynchronous nature of VideoPal meant that the content was archived and could be shared with a group (if desired). Sixty percent of the VideoPal videos were shared with the entire group of six girls and 73 % were shared with more than one person. This type of sharing is missing from synchronous video exchanges. Providing group, social networking experiences, even within a closed group is beneficial to help foster common ground between the members and help build a stronger sense of community. Providing these types of benefits for synchronous video communication would also be beneficial and should be explored in future work.

Offline Awareness

The extended VideoPal study was successful in part because the girls were given their own laptop computers and they spent a great deal of time using the laptops. A more common scenario would be a family having a shared, family computer that the children use from time-to-time, resulting in sporadic (and potentially infrequent) use of the computer. In this scenario, awareness of when the children have new video messages, or when their friends are available for synchronous play, would be extremely beneficial. Offline awareness could be provided through objects such as a mobile phone or a toy.

Conclusion

In summary, previous research had clearly demonstrated that video is a rich medium for children which can be used to support children's play. As the presence of consumer videoconferencing in the home grows, video becomes a viable medium to connect children who are both near and far. Whether it is a quick 5 min conversation, or a 2 h playdate, children enjoy engaging with their friends over video. However, as shown through the work presented here, there is no one perfect system. There are many different types of activities that children want to engage in, within many different contexts. Additionally, children's capabilities and desires can differ greatly with age which will impact which systems are most appropriate. For example, 5-year old boys that want to play together with action figures will have different needs than 13-year old girls playing a board game. Better understanding of the types of activities children want to engage in, as well as the advantages and disadvantages of different technological approaches will help inform the design of distributed-play devices.

One of the most striking observations from the research presented in this chapter was the children's level of comfort with video, and their strong desire to engage with their friends using rich media. We see children as potential media trendsetters when it comes to video communication. Previous generations of youth heavily utilized text messaging as their key communication medium. The next generation of kids will likely leverage the richness of video to communicate and play with their friends. Although more research is needed to better understand the best ways to support children's play over video, we strongly believe that this is the way children (and adults) will regularly communicate in the future.

Enabling children to engage in remote play with their friends represents a new usage model of video. Video is traditionally used to connect people who live far away and don't have an opportunity to interact face-to-face. Much of the research in this chapter is concerned with connecting close friends in a way that augments their existing face-to-face relationship. Just as text-messaging has become a dominant way to interact with close friends, video could also enhance existing relationships. Finally, the children also demonstrated a strong desire to share more than just a "talking head". This suggests the need for video communication to move beyond just conversations, to the sharing of rich experiences.

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