WaaZam! Supporting Creative Play at a Distance in Customized Video Environments

Seth Hunter[1], Pattie Maes[1], Anthony Tang[2], Kori Inkpen[3], Sue Hessey[4]

[1]MIT Media Lab
Cambridge, MA, USA
{hunters, pattie}
@media.mit.edu

[2]CS Department
University of
Calgary, CAN
tonyt@ucalgary.ca

[3]Microsoft Research
Redmond,
Washington, USA
kori@microsoft.com

[4]BT Research
and Innovation
Ipswich, UK
sue.hessey@bt.com

ABSTRACT

We present the design, and evaluation of *WaaZam,* a video mediated communication system designed to support creative play in customized environments. Users can interact together in virtual environments composed of digital assets layered in 3D space. The goal of the project is to support creative play and increase social engagement during video sessions of geographically separated families. We try to understand the value of customization for individual families with children ages 6-12. We present interviews with creativity experts, a pilot study and a formal evaluation of families playing together in four conditions: separate windows, merged windows, digital play sets, and customized digital environments. We found that playing in the same video space enables new activities and increases social engagement for families. Customization allows families to modify scenes for their needs and support more creative play activities that embody the imagination of the child.

Author Keywords

Video mediated communication; customized video environments; composited video; family play; remote play; shared experiences at a distance; play at a distance.

ACM Classification Keywords

H.5.3. Information interfaces and presentation: Group and Organization Interfaces: Synchronous interaction.

INTRODUCTION

Our networks of families, colleagues and friends are progressively more geographically separated [28]. Conventional video conferencing technologies provide a live window between remote spaces but do not typically support users who want to design and interact in a shared video space. Although possible with current technologies, there are very few communication platforms that facilitate creative interaction at a distance. The benefits of creative telepresence systems for families are under-explored in the research literature, particularly in the context of customizing environments. In this work we were motivated by the question: "How can we empower children to build and share worlds with us even when we are apart?"

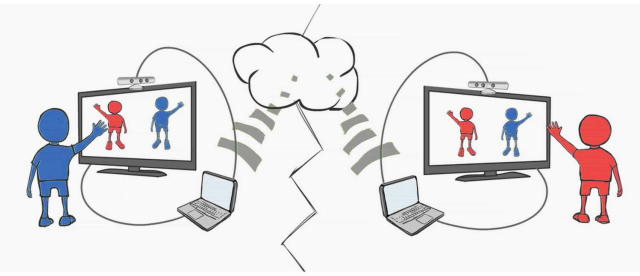

Figure 1: A conceptual diagram of the setup: remote participants are together in the same virtual play space.

The problem we are addressing is that in conventional video communication systems many young children have trouble staying in the field of view of the camera and often become impatient and distracted without an activity [2]. Conventional video mediated communication (VMC) systems (like Skype) do not have tools available for families imagine activities and do them together in a shared virtual space (Figure 2). Prior research [7] has demonstrated potential applications of composited video spaces but no one has implemented a system to allow families to build and play in their own video environments together.

Figure 2. A girl plays in a scene she designed with her mother.

Our answer to this problem and primary research contribution is the design and evaluation of a unique networked play application (Figure 1) called *WaaZam*, which supports customization and creative play at a distance. Customization is possible via the "scene-maker",

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an environment that allows users to capture physical objects, search for digital assets, remove backgrounds and arrange the elements in 3D play-space. Playing together at distance is enabled by the "scene-player", a rendering engine that allows users to interact together, transform their video images and incorporate objects into play sessions.

To contextualize our approach we present findings from interviews with creativity experts, a pilot study and a formal evaluation of the system with children and adult relatives. In the study we use the *WaaZam* system to examine differences between families playing together in separate and merged spaces, realistic and imaginary environments, and customized digital environments. Our results include quantitative data on activities, mutual engagement and play types across conditions and interviews of adults and children. We discuss key insights from our observations, video coded sessions, and interviews of participants.

We are excited to share the results of this work because of the potential improvements to the design of systems for separated and extended family that live far away from child relatives. The design insights and research findings may also interest researchers developing applications in other VMC domains such as language learning, co-broadcasting and social gameplay.

BACKGROUND AND RELATED WORK

Our approach is informed by theoretical and psychological theories of play and creativity. Our system builds on research systems that enable shared VMC experiences in the workplace, gallery, theatre and the family room.

Play and Creativity

Psychologists [11] describe play as spontaneous, self-initiated activities that are relatively risk free and not always goal oriented. Time spent in self-organized, social play is critical to children's social and cognitive development [25]. Sociocultural theorists discuss the importance of play in childhood development as the most significant activity of the early childhood years. [36]. An essential characteristic of play is pretending and imagination in which roles and rules govern the symbolic use of representation [25]. Some scientists consider pretend-play and narrative play to be a key component of innovation and creativity [3].

Our focus on creative customization in the scene-maker is informed by constructionist theories of play, creativity and learning. Developed by Papert [26], constructionism builds on Piaget's [27] ideas that children build knowledge through experience and creative actions they find personally meaningful. Learning theorists [8] argue for designing experiences that are imbued with individual purpose.

Shared Space Collaboration Systems

WaaZam builds on prior work on remote collaboration spaces in the workplace, gallery, theatre, and home.

VMC systems in the workplace have been shown to enhance communication and build trust in organizations [12]. *VideoWindow* [9] was one of the first shared video portals. *VideoDraw* [34] and *Clearboard* [13] unified remote spaces for real-time drawing in a video sketchbook. *Colla-Board* [23] and *VideoArms* [33] extended this work to whiteboards and horizontal displays. The *Reflexion* [7] project used background subtraction techniques to composite viewers on the same screen while they were watching media content together. *MirageTable* [4] and *KeckCaves* [37] combine views from 3d sensors to create the illusion of in the same virtual space together while manipulating data.

VideoPlace [17] was the first art installation that includes a mirror-like representation of viewers in a virtual space. Other artists [32, 19] have extended this approach in the gallery. Roy Ascott coined the term "telematic arts" to describe artists like Paul Sermon who build systems for distributed creativity. *Telematic Dreaming*, *Telematic Vision*, and *All the Worlds a Screen* [31] connected live performance spaces between remote locations. *HyperMirror* [21] projected remote users on the same screen to facilitate cultural exchanges in geographically separated classrooms.

Several projects have been developed in collaboration with the authors. *InReach* [35] explores how users can "reach in" and manipulate 3D data at a distance. *OneSpace* [18] demonstrates that being together in the same virtual space encourages active forms of free play, where children are creatively engaged with their play partners. *Waazam* contributes to this research by adding a creative studio and a rendering engine so users can build and interact together in worlds they construct. We introduce gestural transformation, object tracking, effects and recording to help users to inhabit worlds they imagine together and share their experiences with others.

Video Mediated Systems for Families

According to a Pew Internet survey [28] there has been a steady increase in the adoption of VMC technologies by families living in the US in the last ten years. Of the 74% of Americans in the study with access to the Internet, 24% reported using video calls with family. VMC systems have been shown to be particularly beneficial to families. Using body language, gestures, and facial expressions helps children convey emotion and reduces confusion [20] during VMC sessions. Common ground theory suggests that video communication increases mutual awareness [5] and enables more synchronous activities [5, 1, 14].

Yarosh et al. [42] studied free play at a distance in multiple configurations and found that children's model of the other persons view was vague or incorrect at times. They also found that interacting with toys in conventional VMC systems was awkward because it was difficult for children to manage visibility. They suggest combining local and remote views into a shared view to resolve these problems.

The Illumishare [15] and ShareTable [40] projects subsequently found that combining spaces makes for more natural and seamless interactions.

Several researchers have used a collaboration space to support family activities. The Family Portals [14] and TA2 [43] projects designed shared spaces for drawing and interacting with board games. Nokia Research has several projects that support shared experiences through mobile storytelling [29], putting the child in the story [30], and scaffolding VMC sessions with activity prompts [10].

Research on role of technology to support divorced families [1,41] shows that many families express dissatisfaction with the limits of audio communication and instead sought ways to maintain contact through shared activities and routines but found little technological support to do so while separated. In our user study we try to address this problem by examining shared activities [14, 24], engagement [1], and play types [42] common to separated families. We contribute insights and methods to support creative play in customized VMC environments with this demographic in mind.

DESIGN AND IMPLIMENTATION

This section outlines our design approach, unique feature set and the software implementation.

Design Approach

At the beginning of the project we outlined guidelines that motivated our design approach based on prior work:

1. *Support fantasy play*: *Can I do impossible things?* Children's imaginations are not limited by empirical knowledge. They love superpowers and magic. Fantasy is about enacting the impossible because it is exciting! But it's also a critical part of the child's development. Imagination precedes rule based play, the ability to think divergently, and can assist in helping children imagine the perspective of others [25].

2. *Enable transformation: Can I become something new?* Sherry Turkle [26] depicts online environments as liminal spaces that are both real and fictional; not quite a mirror of the child but reflecting aspects of themselves. Transformation is imbued with surprise and delight because it allows children to experiment with their identities.

3. *Support shared experiences: Can I interact with others?* As bandwidth and hardware capacities increase, synchronous remote systems will support new types of embodied presence. A community of researchers [24] is working to connect families by supporting active, social and creative play in the same virtual space.

4. *Add customization tools: Can I make my own?* We are interested in designing open-ended environments that can embody the imagination of children. By focusing on creative expression we hope to encourage a culture of participation and learning that extends beyond gameplay.

Design Features

WaaZam is a networked video system that allows people to play together in a creative environment that they create and share with others. We refer to the play environment as the scene-player and the creative studio as the scene-maker to describe the feature sets and user experience.

Play Environment

The *WaaZam* system is composed of a networked PC, a Kinect depth camera, and a HD TV (Figure 1). Video, audio, user and scene data is streamed directly between clients via a peer-to-peer protocol (Figure 7).

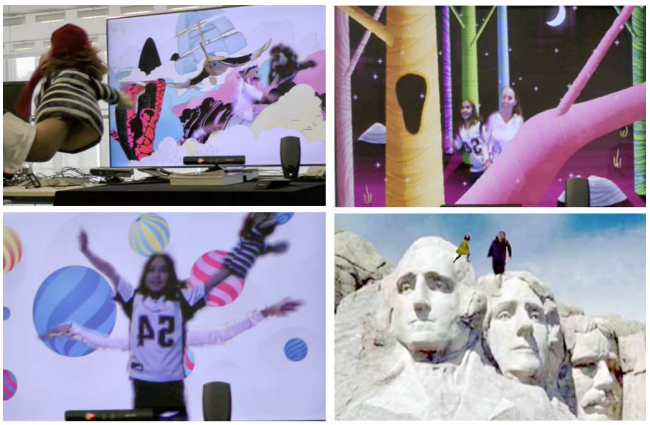

Figure 3. Puppet mode, everywhere mode, transformation in everywhere mode, and ghost mode (clockwise from top left).

The software supports conventional videoconferencing (I see your space and you see mine), a merged "magic mirror" mode (you can appear in my space or I can appear in your space), and constructed fictional environments (where we can be together in digital sets). Users can use gestures or the mouse to transform their video image in the environment. This allows users to step behind objects, hide from each other, and inhabit environment at different scales.

Figure 4. The gestural menu used to select a scene.

The WaaZam environment has several rendering modes (Figure 3). *Puppet mod*e tracks the objects in users' hands and only shows the objects on the screen. *Everywhere mode* tracks the user and supports scaling, transformation, and layering in the depth space. *Ghost mode* allows users to experiment with blending their bodies together and appearing and disappearing at a fixed depth boundary.

Users can select scenes during a networked session with others via a gestural menu (Figure 4). The menu is designed to allow users to switch between scenes and rendering modes (puppet, ghost, or everywhere) during a play session. Users can also choose to record videos from the gestural menu. This feature is designed to allow users to share short videos of play episodes with friends and family.

Scene-Maker User Interface

The scene-maker is composed of an asset menu, a layout canvas, asset management windows, and scene management windows (Figure 5a).

Figure 5. The scene-maker user interface elements.

Users create a library of assets by either capturing physical objects with a web camera or by searching (Figure 5b) for assets by a keyword. Sets are composed of background wallpapers and foreground props (images, animated sprites, or movies) that are placed in the space relative to the position of a user. Individual assets are dragged onto the canvas and can be scaled, rotated and translated via buttons on the corner of the asset (Figure 5c).

A GUI implementation of a segmentation algorithm (Figure 5d) is included to assist with background subtraction and create the illusion of a seamless space. A visualization of an orthographic 3D view (Figure 5e) is provided to allow users to drag elements along a depth axis and select a position in space. The sets are sharable with other users of the WaaZam software through the web syncing function that is activated when users click the "publish" button.

Software Overview

WaaZam was implemented in C++ using openFrameworks libraries for OSX.

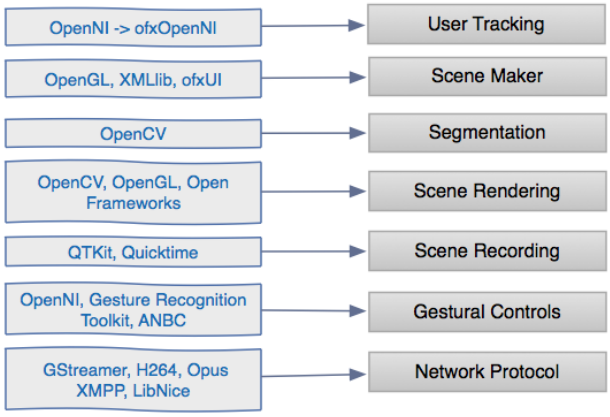

Figure 6. Software dependencies in the WaaZam application.

A high level view of the open source library dependencies is shown in Figure 6 for interested application developers. Further information is available at *WaaZam.com*.

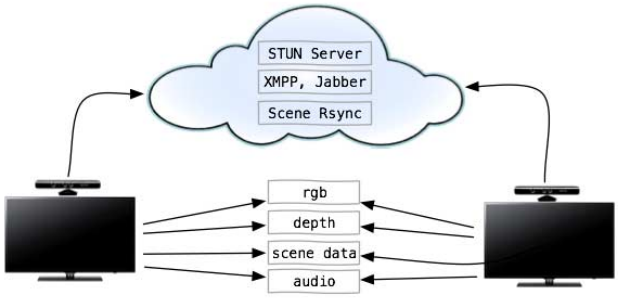

Figure 7. A simplified view of the network protocol

Details regarding the network implementation in Figure 7 can be found online with simplified examples in the OFStreamer [39] toolkit, which we posted for other developers. The protocol utilizes GStreamer libraries and NAT Traversal techniques to synchronize audio, video, depth, and metadata between peer-to-peer clients.

USER EVALUATIONS

This section describes our pilot studies and the design of a comprehensive user study to examine research questions, our system design, and the experiences of adult/child pairs.

Pilot Studies

There are many possible application domains for composite VMC systems. To determine the feature set in our system and to understand how to support creative play we demoed frequently during development and conducted pilot studies with families, educators and creativity experts. We chose family play based on the engagement levels of participants and needs reported by the families in our pilot study.

Creativity Experts

We invited one professional puppeteer, two improvisation actors and two graphic designers to visit our lab on separate occasions. Each of the experts used the system with a remote participant and was interviewed regarding suggestions for improvement, scaffolding the interaction and desired features.

The experts suggested focusing on application scenarios that require coordination between participants because activities like co-broadcasting, improvised skits and live animation were the most social and creative. They wanted more control to determine the content in the system, how participants are rendered, and more creative ways to incorporate objects and props. We subsequently added gestural controls, the scene maker, new render modes, puppet tracking and recording. The experts also made many suggestions that are included in the future work section.

Laboratory Pilot

When the initial play features were completed, we invited 12 participants from 5 families with children between the ages of 4-14 to our lab and observed their behaviors, activities, play types, attention, and engagement. We asked participants to play together for 20 minutes in premade scenes developed based on the recommendations of creativity experts. We monitored sessions and recorded videos to code behaviors and summarize activities after the study. We also interviewed the parents and children to gain a basic understanding of their experiences, debug our system, and identify a target demographic.

Based on our observations and interviews of parents and children we noted some fundamental insights:

- Using real objects increased engagement because it introduced a shared activity that involved object play.
- Children ages 6-11 were the most engaged and get the "what I see is what you see" mirror metaphor.
- Backgrounds that suggested activities such as dancing and play-acting tended to increase engagement.
- Activities differed between genders. Girls tended to do more social role-playing games and activities such as dancing or yoga. Boys tended to engage in body play, play fighting and fantasy role-playing.
- Groups of three competed for the camera view and were not as cooperative as one-on-one groups.

Some general trends can be seen in the data from our informal observations. Participants were very engaged in pretend play and bodily movement was higher when they were in the same virtual space. Coordination between participants, visibility and attention suffered at times when the background scene did not suggest an activity. The child participants had many suggestions for content and activities and indicated that they had strong preferences about what the environment should look like.

Formal Study Design

Following the pilot studies and creativity recommendations, we developed the scene-maker, added gestural navigation, improved tracking, and added recording capabilities to our system. We also consulted with researchers who have done prior work on VMC systems for families to design a comprehensive study to examine the effects of different configurations on play behavior.

Research Questions

We designed the structure of our study to correlate our findings with prior research [42, 24] and examine the features of the scene-player (fantastic sets) and the scene-maker (personalization) separately. The resulting research questions can be divided into three areas:

1. *Separate vs. merged spaces:* Does being together in the same virtual space enable families to have shared experiences not available in conventional VMC systems? If so, what are the activities that repeat across participants?

2. *Fantastic vs. realistic sets:* How do play patterns, activities and behaviors of participants differ in imaginary sets? What types of set designs promote shared activities for families?

3. *Customizing environments:* Does allowing participants to create their own play environments add additional depth, richness and meaningfulness to the play experience? Do our customization tools serve the needs of individual families?

Study Procedure

We recruited 12 adult/child pairs and informed them that we were studying family connectedness and needed their assistance finding fun activities to do during video play sessions. We scheduled two 90-minute sessions (Figure 8) two weeks apart to allow families to accommodate to the novelty, learn the features, and reflect on scene designs.

Session 1 was focused on getting to know the participants, assessing play across three conditions, and introducing the scene-maker. Session 2 was focused on customization with assets from their lives, addressing novelty factors by extending playtime, and interviewing the participants.

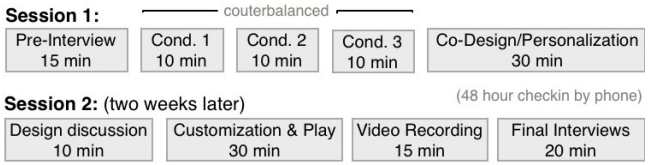

Figure 8. A timeline of the study procedure.

In session one we interviewed adults and children individually to determine their technology experience, frequency of VMC use, existing play patterns, personal interests, and rating of connectedness to their playmate. Participants were brought to separate spaces with physical props in the room such as puppets and toys. They were asked to find the most fun thing to do in three counterbalanced 10-minute sessions (Figure 10). The session conditions were: Skype (conventional VMC configuration), magic mirror (participants are composited into one window with the background of one of the participants), and digital sets (fictional background sets with layers designed by artists).

This was followed by a co-design session where groups discussed ideas for a new scene, used the scene-maker tools with the facilitator, and played in one of the sets they made. After the first session we gave each group a thumb drive to archive images and movies between sessions.

In the second session the participants used the scene-maker to design a few more sets with physical and digital assets they brought from home. We asked them to play in these customized sets and record a short video. We concluded the sessions by conducting post-interviews of the parent and child regarding their experiences and suggestions for future use cases.

Study Participants

We selected groups based on the child's age and the number of days the adults and children are away from each other each month in order to focus on geographically separated families.

Group	Adult A/S	Child A/S	Same home	D. away p/m	Use VMC	Use phone
1	43/f	10/m	no	8	some	often
2	42/f	8/m	yes	2	some	often
3	36/f	10/f	yes	0	none	none
4	70/f	8/f	no	20	some	some
5	43/f	10/f	yes	0	none	some
6	38/m	8/f	no	10	often	often
7	38/m	7/f	yes	0	none	some
8	43/f	12/m	no	15	often	often
9	47/m	12/f	yes	1	none	some
10	48/m	11/m	no	2	none	none
11	49/m	6/m	no	15	some	often
12	45/m	8/f	yes	18	often	often

Figure 9. Pairs: age, sex, days away per month, and VMC use.

Figure 9 shows the age of the adults and children, if they live in the same home, the number of days they are separated each month, and the group familiarity with video communication technologies. We selected seven groups who have a real need to connect due to travel, divorce, or work related geographical separation. Six of the groups were familiar with VMC technologies and use them occasionally. Nine of the groups were parent/child relationships and there were two grandparents and one aunt. Many participants stated that they responded to the study to learn about ways to connect with the child when they were apart.

Video Coding Criteria

During play sessions we recorded video of the screen and each of the physical play spaces. We coded videos using the following metrics:

Type of Play: The National Institute for Play [22] identifies patterns that constitute elements of play. We coded for body play, object play, social play, pretend play, and narrative play. We used a binary coding technique to determine if a play type occurred in a 15 second interval.

Adult/Child Play Engagement: We examine play mutuality using the Piaget/Parten Scale [31], which rates levels of play engagement on a scale of 1 to 5 in intermittent states progressing from solitary play to parallel play to associative/cooperative play activities.

Adult-Child Mutuality: The Adult-Child Rating Scales [6] developed by Crawley and Spiker (1983) were coded for each play episode. They are rated from 1 to 5 in two sections: child measures of play maturity, social initiative, and object initiative and adult guidance ratings of directiveness, elaborativeness, and sensitivity.

Behavioral Characteristics of Participants: We marked if a pair smiled, laughed, or made a non-word exclamation like "ahhh" every 15 seconds. We also noted if the attention of the child and adult were on themselves, the other person, the mutual activity, the virtual space, or the physical space.

To ensure the reliability of our coding criteria, two researchers outlined a procedure and coded the first group together, discussing engagement, attention, and play types for each 15-second interval. Then they coded a second group separately and computed a Kappa scores between .6 and .8 for each metric. Each of the videos was coded twice once for episodic characteristics (activities and adult-child mutuality) and again in 15 second intervals (play types, behavioral signals like smiles, engagement, and attention).

Results

We present our observations, the results of the coded videos across four conditions (Figure 10), a summary of the most common activities and qualitative feedback from participants on customization and desired usage scenarios.

Observations During the Study

In Skype mode show and tell and object play were the most common activities. Engagement was loosely correlated with children that had high social initiative and adults who were directive and sensitive.

In the second condition participants exclaimed in surprise when they first saw each other in the same space. In mirror

mode, body play, mock fighting and tickling, playing with the camera, and object play commonly followed. Participants focused more on each other in mirror mode.

Figure 10. The four study conditions (from top left clockwise): skype, mirror, customized and digital.

In digital mode participants explored and inhabited the environment as families might in a new playground. The most popular scenes had lots of layers or suggested an activity. Common activities in digital mode included exploring layers, hide and seek, shrinking to the scale of the scene content, pretending to inhabit the virtual spaces.

Figure 11: Example customized scenes: flying with harry potter, meeting Obama, eating together, and a dance party.

During customization families had more intentional activities and specific preferences. In the second session groups were less focused on novelty and more interested in enacting ideas the child had expressed. Most groups would make a scene, try it, and then return to make small modifications. Groups with more supportive parents seemed to have higher engagement in both sessions. Adults and children reported that the customization tools allowed them to make the scenes they imagined but they wanted more interactive features like driving a car and costuming.

In customization mode the behavior of groups was highly individualized (Figure 11). Some groups were interested in creating familiar spaces while others were attracted to more fantastic backgrounds such as a movie set. Other groups created backgrounds for physical activities like dancing or swimming. Please see the video figure for specific examples of individual group play activities.

Summary of Activities

Of the top ten activities in our study, eight were collaborative activities with a component of pretend play. Parents reported their favorite highlights as body play (8), hide and seek (4), exploring an environment with the child (3), playing with puppets together (3), and creating sets (3).

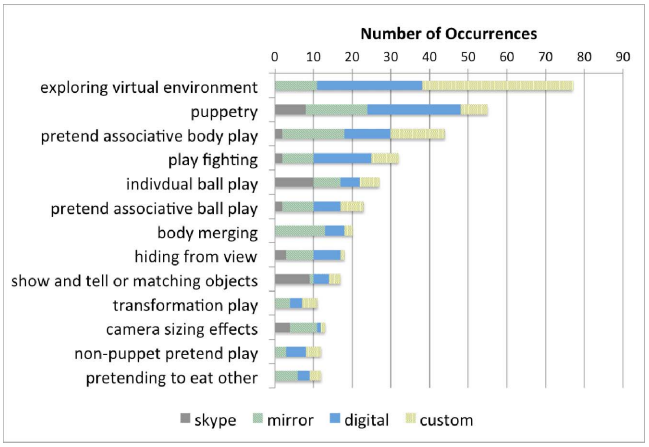

Figure 12. Top activities across conditions in the study.

Children reported their favorite activities as customization (7), being in the environment (4) being in scenes they made (4), transformation (3), hide and seek (2), being with the parent (2), and playing with glitches (1). The total numbers of occurrences of top activities are shown in Figure 12.

Engagement and Types of Play

Figure 13 shows the subjective ratings from interviews with participants rating engagement and connectedness across conditions.

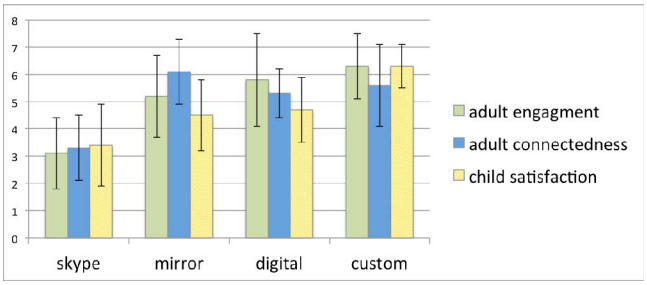

Figure 13. Adult and child ratings of the four conditions.

Overall the findings indicate an increase in engagement in the custom condition and low engagement in the Skype condition. Children gave customization the highest rating. Adults felt more engaged and connected in merged configurations (mirror, digital, and customization) than in Skype. Adults reported that the mirror condition was the most viscerally fun because body play felt more intimate. They reported enjoying digital scenes but felt less connected when they were not engaging in a shared activity.

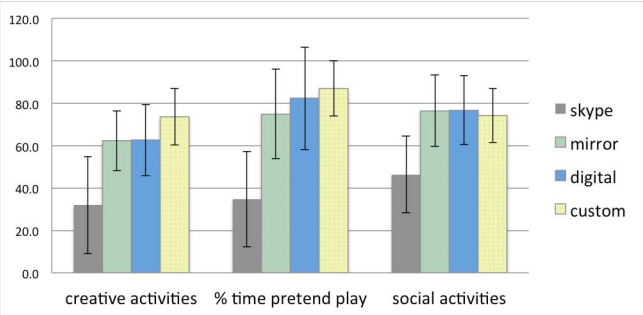

Figure 14. Creative activities, pretend play, and social play.

Figure 14 shows common types of activities grouped across conditions. Social activities and pretend play were 28-46% higher across all three merged configurations than in Skype. Being together in the same space appears to be the most important factor to supporting more creative and social activities.

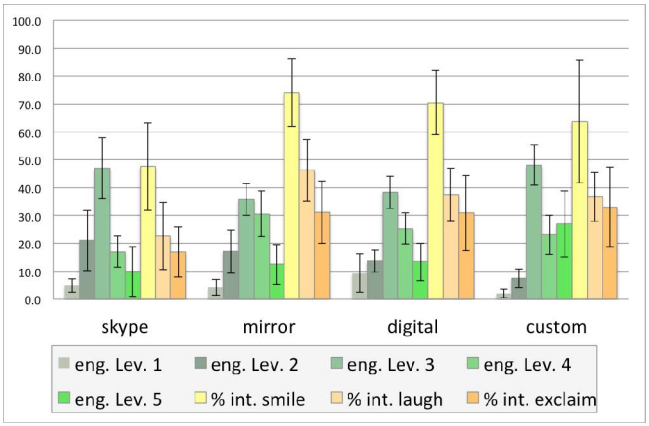

Figure 15. Engagement levels on a Piaget/Parten scale of 1-5 and intervals with smiles, laughs and non-word exclamations.

Although play is subjective and unique to each group, the observed data from the videos reflects key observations from the interviews. Overall engagement was low in Skype and differences in behavior between mirror, digital, and customization were more nuanced. Groups had more frequent engagement at the level of 5 in custom mode (Figure 15), but spent more time smiling and laughing in mirror mode because they were more directly engaged with each other's bodies. The standard deviations resulted from differences in play styles. For example, groups that engaged in pretend play in digital and mirror conditions were more likely to have higher engagement in the custom condition. Please refer to the video figure to relate these findings to specific examples of group play for each condition.

Customization Feedback

Between digital and customization conditions families shifted from adapting to the environment to directing activities. Customized scenes expressed more about the personalities, memories, desires and needs of families. The scene-maker was challenging for the 6 and 7 year olds but was much easier for the three 8 year olds who had some technology experience. Most of the children thought customization was fun because they could do anything they wanted and the content related to their interests. Regarding remixing scenes, many preferred to have direct ownership:

"I like modifying other peoples sets but since mine are better I could make my own with their backgrounds"

Most parents reported they were inclined to support the child during the scene making process. They also reported that customization allowed them to adapt the environment to specific needs. One grandparent and her granddaughter brought pictures from recent trip together. They made a scene with a lake and pretended to go swimming together. The grandmother said she enjoyed playing because:

"I could do things that are not possible for me in reality. For example, I am not a very active person anymore but I could run up the walls with her or swim with her."

One mother saw customization as a way of enacting her son's ideas with him. Her son had drawings of an imaginary trip to Paris where he said they visited a café and climbed the Eiffel tower together:

"What was interesting for us is that we can act out his ideas and then I can help him develop them into something that we can do together in his worlds."

Having a supportive partner is a key component of customization. One grandparent was not very sensitive and directed activities frequently. The child said that playing in scenes was more fun than creating them because she had to design the scene for herself and her grandmother's preferences.

Usage Scenarios

All of the adult participants said they would use the system as an alternative to conventional VMC systems. Many parents said they would start in mirror mode so they could be with the child in their home and catch up on their day and proceed to a digital mode when they wanted to play together. Parents suggested activities like inviting children into travel pictures while on a trip, eating together in their home kitchen, and reading a bedtime story in a picture book. Children said they wanted do things like flying a plane, going to a foreign country, playing with toys, making movies, playing with each other, and making new scenes.

One third of the groups had a real need for the system because the adults are separated from the children more than two days a week (because the parents are divorced). As a result, they expressed interest in a home installation of *WaaZam*. These families were the most emotive during the post-interviews and had the most suggestions about how they would use the system. For example one father really missed his daughter and wanted to try enacting familiar scenarios. His daughter had similar ideas about what they would do together saying:

"I would have a sushi picnic with my dad, show him my cat, have him tell me a story at bedtime, play with toys, and make different backgrounds to show him where I've been"

In contrast another child said that he felt closer to his dad on the phone than in our system because he can tell him whether he had a good day or a bad day. *WaaZam* may help these families have fun together by supporting video play but it might be best to use in tandem with media that provides privacy for children to establish an emotional connection with the adult.

DISCUSSION

As use of VMC systems in the home increases [28] and researchers focus on developing shared video spaces for families [24] we hope the following insights can serve as design guidelines that encourage the development of more creative systems which empower families to build worlds that serve their individual needs.

Regarding the initial research questions, like other researchers [18, 42] we found that being in the same space increased play engagement and made more shared activities possible. Our analysis of activities indicates that social, body, and pretend play are more prevalent in when participants are in the same space.

Engagement was higher in the mirror condition but pretend play and coordinated activities increase in the digital condition. Using the analogy of *WaaZam* as a playground provides a context for understanding the behavior of participants and the value of scenes that suggest active, social and creative activities. Customization is important to children because they develop feelings of ownership and are able to enact their ideas and share them with the adult participant.

Our findings can be summarized as the following key insights:

1. Being together in the same virtual space enables new activities, tends to increase play engagement, and increases the diversity of play types.

2. Support shared activities by: using suggestive scenes, adding interactivity, and providing customization tools.

3. Digital scenes are like going to the playground and customization is like designing your own playground.

4. Personalization appears to foster feelings of ownership, and can increase the richness and depth of play activities.

5. Playing in customized scenes fosters creativity and communication by allowing children to enact their ideas.

6. Families play in many different ways. Provide support for active, social and creative play scenarios.

CONCLUSION

In this paper, we presented the design and evaluation of the *WaaZam* system, which is uniquely focused on helping families build and play together at a distance in customized VMC environments. The system places remote users in the same virtual space and includes support for object play, body merging, transformation, and gestural interaction. The scene-maker allows users to author, share, remix and record content in customized environments.

In our future work plan to improve the platform by adding contact management, increasing interactivity, letting users map effects to specific props, adding parental controls, and scaffolding storytelling activities. We also plan to do a study of our system in the home. The use of the system in everyday life (including the effects it may have on existing behaviors and choices of communication) will need to be tested in longitudinal studies to understand the implications of our approach long term. Although we were able to reduce some of the effects of novelty by having extended play sessions in the second session, we don't know how families would use the system over the course of many months. Our hope is that providing customization features will encourage long-term use because participants take ownership of the environment.

Central to our aspirations is the question: How can we empower children to build and share worlds *with us* even when we are apart? We found that when adults and children are together in the same video space it enables more creative play activities and tends to increase feelings of connectedness and engagement. But what was truly satisfying about this research was watching children customize environments in creative ways that were personally meaningful to them. Seymour Papert said: "Computers serve us best when they allow everything to change". Papert's work empowered children to construct their own understanding of systems by building worlds. We believe that when we are separated, children should be able to design new and delightful experiences that build their imaginations and strengthen our relationships with them.

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