1. Introduction

Storytelling is a way of conveying a message with speech, sounds, movement or imagery. It is an inherent form of communication and entertainment, an ancient tradition. A story box is an age-old concept of an item that contains a collection of images and features to remind people of a story and to give them visual focus when the story is told. Related traditions are present in many cultures such as kamishibai in Japan and kavat in India [1,2]. Modern environments especially designed for storytelling are diverse. Restricted areas like story rooms, mats and boxes combining digital material and physical objects have been created to complement and enhance especially children's storytelling [3,4]. In digital interactive storytelling computers, projectors and screens are used to create immersive environments to present stories that may be branching but are nevertheless predetermined [5,6]. A particular form of storytelling is improvisational theatre where actors and audiences create a story from cues originating from their reciprocal interaction. Improvisational theatre is an inherently creative and playful way of telling a story. While there are already many games to aid improvisational storytelling, not that many of them make use of digital media or game technology [5,7–9].

In this paper we present Props, a 3D-game-like system for mediating collaborative and improvisational storytelling. As a platform for storytelling, Props first creates a virtual 3D scene depicting a performance stage that is modelled in detail after a real-world performance stage at downtown Oulu, Finland. The virtual stage is presented to the audience in a suitable manner, for example on a laptop’s screen, as a large-scale projection or in a computer assisted virtual environment (CAVE). Together with the surrounding real world, the virtual stage establishes a hybrid space for collaborative storytelling. A prop master sets the stage for a story with a computer, by selecting from an inventory of virtual 3D assets a background, a scene and various objects and effects, i.e. virtual props placed on the virtual stage. The props serve as cues to a narrator who narrates the story by speaking or acting. The iterative and collaborative process of staging, narrating and acting goes on until the players agree that the story has been told. In its simplest form Props can be played by two people, a prop master and a narrator, with a laptop. However, we have targeted Props to larger audiences so that the virtual 3D stage is projected onto a large flat surface or on the multiple walls of a CAVE, and the members of the audience dynamically take different roles during storytelling. To explore the narrative potential of Props, we conducted three field trials involving eight separate storytelling events where Props was played by audiences from different age groups. As a theoretical framework in the analysis of the storytelling events we employ an extended model of the Church-Murray aesthetics of virtual environments (VEs) [10], adding enjoyment as a fifth dimension to the original four dimensions of agency, narrative potential, transformation, and presence and co-presence.
The remainder of the paper is structured as follows. We first review related work on digital interactive storytelling systems in Section 2. The design and technical implementation of Props and a pilot study conducted with children are presented in Section 3. The theoretical framework of the study is introduced in Section 4 with illustrative observations from the pilot study. Section 5 outlines research methods, the field trials and the materials collected from the storytelling events. Section 6 presents the analysis and results, first for each field trial and then for selected dimensions of the theoretical framework. Section 7 discusses our findings and Section 8 concludes the paper.

2. Related work

Storytelling aids in creative processes, coincides with children's literacy development, cements social bonds and provides insights on silent knowledge in social situations on small scale or in big organizations [3,11–14]. Storytelling systems for fictional storytelling are mainly targeted at children; hence much of the research on them has been conducted in collaboration with child audiences [3,4,15]. There is an inherent agreement that storytelling is also a part of adults' communication, though. Collaborative fictional storytelling is used with adolescent and adults to create social interventions [11–13] and in play and narrative therapy. Yet there is little research on expanding storytelling systems to audiences outside child demographic [16].

As stories are evolving into digital and visual form, so are the sites where they are told changing. Digital interactive storytelling (DIS) systems are designed to support static story content although they have slight differences in how much the participants can affect the authoring process [17,18]. DIS systems are not to be confused with storytelling support systems that are designed to complement freeform storytelling. They often rely on either static images that can be very suggestive [13] or at the opposite end of spectrum are too generic to inspire [19]. When storytelling support systems are designed for inspired improvised storytelling and acting, some amount of suggestion must come from the game content. Then again, the content should not be too static to prevent the storytellers from having freedom with the storyline or force them to ignore the suggestions of the storytelling system and other participants. Traditionally, immersive environments for digital storytelling have been demanding to set up, and they are constrained to participants the same experience with less effort. When the virtual 3D scene is visualized on a screen, the output is always a flat surface. However, repositioning multiple props on the stage brings out depth perspective which is further enhanced by animated objects and effects, creating the illusion of extension of space into the stage. Monocular cues to depth perception, i.e. those that can be perceived with just one eye or from a flat surface, are more dominating in creating the illusion of depth than binocular [20].

3. Props

3.1. Design

Stories are elemental in most games, but most games are not just about telling a story like Props. The initial motivation for Props was to create a pervasive storytelling game for an upcoming 3D virtual model of the City of Oulu in northern Finland. The basic idea of the game is to mediate collaborative fictional storytelling and to expand the storytelling event into hybrid environments. Although Props stage spans two realities, the virtual stage in the 3D virtual model of the city and the real stage, the actual physical stage used in the game play does not have to be tied to any specific location. The real-world stage houses the players who can adopt different roles during the game play. Narrators tell the story, prop masters set the stage and audience enjoys the play.

There is no obvious competition in Props, unless one accounts the dynamics between the prop master and the narrator as some sort of battle of minds. There is no declared winner or winners at the end, but everyone gets the same reward, the story that they have created in collaboration. Some forms of games are similar in this regard, sandbox games or simulations like Sims or Microsoft Flight Simulator and performance games like Guitar Hero or SingStar. The lack of competition and too much stress can support creativity [29].

One could argue that having paper cut-outs as props could give the participants the same experience with less effort. When the virtual 3D scene is visualized on a screen, the output is always a flat surface. However, repositioning multiple props on the stage brings out depth perspective which is further enhanced by animated objects and effects, creating the illusion of extension of space into the stage. Monocular cues to depth perception, i.e. those that can be perceived with just one eye or from a flat surface, are more dominating in creating the illusion of depth than binocular [30].

3.2. Technical implementation

Props is implemented as a 3D scene atop the realXtend open source game engine for building collaborative 3D virtual worlds [31]. The 3D scene is modelled after a real-world performance stage located at downtown Oulu, Finland, and its surroundings (Fig. 1). The 3D scene is viewed with dedicated viewer software called Meshmoon Rocket that is available for Windows and Mac OS [32]. The 3D scene can be hosted either locally on a PC or in the public Internet on a Meshmoon server [33] which is a commercial instantiation of the realXtend server. If so, then also remote participants can connect via the Internet to the Props scene to view and potentially modify the configuration of the scene. A PC equipped with the Meshmoon Rocket software is needed to use the Props. The 3D scene is visualized in a suitable manner, on the PC's display, on a separate screen, as a projection, or in a CAVE.

The user interface of Props includes a menu for selecting backgrounds, scenes, objects and effects from the 3D asset inventory, i.e. props that are placed on the 3D stage (Fig. 1). The prop master can move, add and delete props with keyboard commands, either individually or in groups. The menu also includes a random button
that places a background, a scene and one random item to the
stage, to instantly nudge the story into a new direction and to
inspire improvisation. The asset inventory can be modified offline
so that newly created assets are loaded into Props upon the next
launch. The asset inventory has been expanded during the study
based on the feedback from the participants in the storytelling
events who have requested new objects and effects. The current
Props inventory (Fig. 2) has three backgrounds, nine scenes and
38 prop items. Most of the props are animated. The three alternate
backgrounds depict sky at night, dusk and day. The scenes include
settings like space, forest and room, to name a few. A static prop
like a car becomes animated if it is selected and moved from one
side of the stage to the other. The selection of props also includes
weather effects like snowflakes falling from the sky which is an
example of a particle effect with no tangible mesh. To enable
moving around and removing all props added to the stage, they
are also represented as selectable icons (Fig. 2(d)).

3.3. Pilot study with children

We illustrate how Props mediates storytelling with a pilot study
conducted with children [34]. It was arranged in a 15-min timeslot
at the very end of children’s storytelling hour during the 2013 Oulu
Improvisational Theatre Festival. The event was arranged in collab-
oration with the Unique Unicorn performance group that conducts
improvisational theatre targeted at both children and adults. Seven
members of the group were present and four of them took actively
part in the event, three acting in front of the screen on which the
Props 3D scene was projected and one as a narrator at the side with
a clear view to the stage (Fig. 3(a)). The audience included four

Fig. 1. A screenshot of Props, where several objects are placed on the virtual stage. Main menu of the game can be seen on the right.

Fig. 2. Examples of Props asset inventory: (a) background depicting sky at dusk; (b) winter scene combined with night sky; (c) cow and UFO are individual props; (d) snowfall and hearts are particle effects.
adults and five children of which two got to play the game as prop masters (Fig. 3(b)). Material gathered included field notes and questionnaires returned by three members of the performance group.

Insight into the narrative potential of Props is provided by the following transcript of the storytelling event:

"Children were very fond of easy options and the "Random" button hence the starting scene was a sunny beach and a cow. One of the performers became a mermaid who was whisked away to a city scene by the "Random" button, swiftly named as "time vortex" by the narrator. The skin of the mermaid began to dry and crackle. She hoped for a change in the weather. Prop master heard her wishes and was able to conjure snow fall from the prop selection. Snowflakes melted into drops of water on the lower arm of the mermaid who was caught in a time vortex and travelled through a forest into a room scene. The prop master was changed without much disturbance to the storytelling. In the room there was a snowman... (this amused the children in the audience greatly) ...and an elephant. It was noticeable from the children in the audience that they were exhilarated of the fact that they reacted to the elephant before the performers and the storyteller noticed it. Mermaid got whisked away back to the beach where other performers were already waiting her, acting as concerned parents, welcoming their daughter home with open arms. Our tiny prop master had just gotten the hang of it and whisked the end scene into the room. Narrator acknowledged this by noting: "They lived happily ever after in the snowman's pad"."

The performers were in favour of mixing Props type technology and game into a storytelling event, but were not willing to do so during every story hour. Two out of three performers returning the questionnaire agreed that Props had a positive effect on the story hour: "It was great fun to improvise in front of a changing scene, but the best part was the enthusiasm of the children as they got to affect how the story went". The performers' acceptance of Props in storytelling has since been confirmed by our continued collaboration with the Unique Unicorn group.

4. Theory

As the theoretical framework in our study we extend the Church-Murray aesthetics (dubbed 'model' from now on) of Virtual Environments (VE) proposed by Fencott [10] as a combination of Murray's aesthetics of interactive digital media [35] and Church's abstract formal design tools for computer games [36]. The original model spans the four dimensions of agency, narrative potential, transformation, and presence and co-presence, which are briefly introduced below with illustrative observations from the pilot study.

Although the original model was introduced in the context of analysing a computer role playing game and applied to interactive digital storytelling (DIS) [37], we find it suitable for analysing Props, a hybrid storytelling environment incorporating virtual and physical realms. The two main differences between storytell- ing systems like Props and conventional DIS are (1) the level of independence the participants have in authoring the stories, and (2) the relative proportions of real life and VE in constructing the hybrid space where storytelling is set. The shared characteristics of agency, narrative potential, transformation, and presence and co-presence can equally be found in PC games, in DIS and in collaborative storytelling mediated by Props.

Agency refers to the sense of feeling in control that is composed of intention (the formulation of goals and plans of actions) and perceivable consequence (perceiving the environment to change as a result of intentions put into practice). In the pilot study with the children the narrator and the prop masters were obviously players in the game, but many of the story's characters such as the mermaid, the elephant and the concerned parents were portrayed by the actors on the stage. The agency of the children manifested not only in their ability to change the stage (where they preferred easy choices such as the random button), but also in their capability to affect the narrator and the behaviour of the actors by reacting to changes in the scene.

Narrative potential corresponds to the accumulation of meaningful experience as a direct result of agency. Narrative potential allows users to construct their own suitable narratives, thus arising from agency but not being determined by it. Some simplify narrative potential as the resulting narrative. In this paper we refer to narrative potential but evaluate it from the stories recorded during Props game play. In the pilot study the 15-min story had a beginning, clear structure in between and a likely end, demonstrating meaningful narrative.

Transformation refers to the capability of the environment to give players new temporary skills, powers and forms. In a computer game this could be the ability to become a hero or a villain in a story, for example. The pilot study illustrates how acting and becoming a character, e.g. being inspired to become a mermaid because the story is set on a beach scene, is a display of transformation. A storytelling system differs from a computer game in that the transformation relies more on the imagination of the participants than it does on the narrative. Furthermore, the narrative can change as a direct result of transformation.

Presence and co-presence correspond to the participants' sensation of not only being in the hybrid environment but also being
present there with others. In the pilot study this manifested as the performers’ well-rehearsed way of observing and reacting to each other’s cues and the props. Furthermore, the children jointly reacted to changes in the scene e.g. the appearance of the elephant, where after the narrator glanced at the screen and declared: “... and an elephant.”

Finally, inspired by Fencott’s allusion that his model is not necessarily definitive and factors depending on what application domain it is applied on can be quite different, we extend the original model by adding enjoyment as a fifth dimension. The main purpose of this is to use enjoyment together with narrative to assess the success of Props in mediating storytelling. Adding enjoyment as a separate entity also connects narrative potential and the other three dimensions of VEs (Fig. 4). During the pilot study children chuckled and laughed as a direct consequence of displays of their agency and presence and co-presence.

5. Methods and materials

5.1. Research methods

Methodologically, our explorative and investigative study did not depart with any particular strictly defined hypothesis to be (dis)proven. Instead, we evaluated Props by conducting three field trials involving seven storytelling events with different audiences in real world settings and collected rich field data including observations, interviews, questionnaires, photos and video recordings. From the resulting largely qualitative data we seek to identify the distinct features of Props that make contributions on the five dimensions of the theoretical framework, particularly in terms of agency, narrative potential and enjoyment.

In terms of agency, our main goal was to understand how Props mediates storytelling and if it was in fact used in a way that affected the stories. We explored agency by observing the significant poses and the changes in the direction of interaction between the roles that the players took during storytelling.

The narrative potential of Props is assessed by analysing the content of the told stories. One of the simplest forms of content analysis of narrative is explicit analysis, where words or phrases and their frequencies are picked from text [38]. Content or word clouds are more commonly used to visualize data in qualitative research. Although they are most suitable exploratory tools for recognizing trends from big data sets [39], word clouds can also give some insights into small data sets such as our stories, especially when they complement knowledge gained by other means [40]. The use of factual stories is already established in sociology and anthropology. Fictional stories can be used to validate deductions made of interaction, particularly when a story is constructed in collaboration [14,41].

The level of perceived enjoyment of the participants can be assessed from involvement, presence and emotional cues like collective laughter. Both objective and subjective measurements can be combined to assess the enjoyment of an event, acknowledging that their results may differ [42].

5.2. Field trials

In the following we briefly report the setup, participants and research material of the three field trials. Reflecting the explorative character of our study, the trials evolved with respect to their setup, execution and collection of research data. Also, Props asset inventory was expanded between field trials based on the feedback from the participants.

5.2.1. Field trial 1: adolescents in conference room with projector display

Field trial 1 was arranged during the Science Day of the University of Oulu where research conducted at the university is annually showcased to visiting upper elementary and highschool students in the form of demonstrations and presentations. Props was set up in a conference room with a projector display (Fig. 5). Three 50-min storytelling events with groups of adolescents of 14–16 years in age were hosted. However, one of the events was so crowded that video recording failed; therefore it is excluded from the video analysis. The remaining two events had 20 participants in total. Both events started with a brief introduction of the Props and warm up play before the actual game play.
Emphasis was on improvisational play and acting, and guidance to the art of improvisation was provided by one member of the Unique Unicorn group. The large number of participants allowed them to play all three roles: narrators, actors and prop masters. Roles were changed between stories, so that everyone got a chance to try out all three roles. Research data was collected in the form of video recordings, questionnaires and story transcripts.

5.2.2. Field trial 2: adolescents in CAVE

Field trial 2 was otherwise similar to field trial 1, but this time Props was set up in a CAVE (Fig. 6). Three 50-min storytelling events were conducted under the guidance of two members of the Unique Unicorn group. Again, research data was collected in the form of video recordings, questionnaires and story transcripts. However, video recording failed in one too crowded event, thus video analysis includes the 17 participants of the other two events.

5.2.3. Field trial 3: adults in CAVE

Field trial 3 was also set up in a CAVE (Fig. 7). Two storytelling events were held under the guidance of a member of the Unique Unicorn group. The first event had four adults and the second event three adults as participants. Attending four men and three women were at an average age of 36 years. They sat on pillows in a story circle throughout the 50-min event that also included a brief introduction of Props and a warm up improvisational play including posing and acting. One participant played the prop master and the remaining participants narrated the stories in turns. The main form of narrative was spoken. Research data was gathered in the form of video recordings, questionnaires and story transcripts.

5.3. Materials

Table 1 summarizes the setup and materials of the three field trials. While the storytelling events had different target audiences and slightly differing settings, their overarching dimension was that storytelling was mediated by Props under the guidance of seasoned performers, i.e. the members of the Unique Unicorn group who have established a routine in conducting improvisation workshops. To add accuracy and transparency to the descriptions and upcoming interpretations of the settings, the notable differences between the three field trials are reported in Table 2.

6. Analysis and results

We first briefly analyse the field trials, highlighting selected findings relevant to the theoretical model. Then we look at three selected dimensions of the model, i.e. agency, narrative potential and enjoyment, in the light of data from multiple field trials.

6.1. Field trials 1 and 2: adolescent in conference room and CAVE

Although spoken narrative was not abundant in the storytelling events with adolescents, some of the scenes played were witty.
example, a boy was instructed to take a pose in front of a scene depicting a beach. He posed as if he was about to dive. The scene changed into a meadow and the guide asked the boy if he was planning to dive into the grass. He replied “I’m not diving, I’m the rainbow”, in response to the rainbow prop that had just appeared on the virtual stage. The adolescents’ acting was imaginative. When an apple tree burned down in a story, one of the participating boys laid down on the floor to act a pile of ashes. Props enticed their transformation from plain humans to trees, bunnies, weather phenomenon, gravestones and whatever items were suggested by the stories.

Especially in the CAVE the adolescents used the whole physical space available. Without exception, their stories began with a description of what was on the Props stage at that moment. When the initial setting was comprised of a day sky, a city scene and a moon the story began: “Once upon a time there was a silent city. What was weird was that in the middle of a day the moon was shining”.

As one comparative metric for agency between the two settings, we analysed from the video recordings how the adolescents positioned themselves in the space against the backdrop of the virtual stage (Table 3). Crouching, sitting, lying down or stretching one’s hands above shoulder level were considered the “big poses” that were coded. Only the leading poses were taken into account, i.e. any follow-up poses taken to mimic the leading pose were excluded. The number of participants corresponds to the total number of people that were at the stage area during warm up play before each storytelling event. We see that on average adolescents took almost twice as many big poses in the CAVE than in the conference room.

### 6.2. Presence and co-presence during field trial 3: adults in CAVE

The guide performer took the responsibility of starting each story in the adults’ storytelling and the ends were announced with a common agreement. The main form of narrative was spoken as participants sat on pillows during the event. The first story was told from the perspective of a bunny, the prop that got everybody’s attention when it first appeared on the virtual stage. The second story was a first person tale of a holiday trip to Egypt and the moon. A quote from the conversation after the second story: “There were nice moments of insight there. Like all of a sudden there was a rocket available in the Bazaar and we were on a trip to the moon”, “You can find anything in the bazaar”, “But the story worked and we accepted everything into it no matter how weird”.

The adults’ sense of presence of the story and storytelling environment and the co-presence of other participants was assessed with a number of statements in the questionnaires. From their responses in Table 4 we can see that most of them felt like they were a part of a story or a play and that they did acknowledge each other’s presence.

### 6.3. Agency during all three field trials

As one manifestation of agency, we counted from the video recordings of the field trials how often the story being told was affected by the interaction between particular roles and the Props stage. Table 5 shows the observed occurrences for most frequent interactions. We see that the Prop master → Narrator interaction had most influence on storytelling. The potential of Prop master → Props stage was constrained by the limited selection of Props inventory. The stories contained many items that were not available in the Props inventory, e.g. hind-leg and grid iron.

At first glance this simple analysis may seem like stating the obvious. However, it emphasizes that there can be multiple separate channels of influence for the participants during improvised storytelling with Props. These channels also reflect the possibilities...
to expand the storytelling event from having everyone situated in the same space to remote virtual participation that has been planned for Props in the future.

As another manifestation of agency, Table 6 shows the frequencies of different roles that the participants reported to have taken in the questionnaires. The adolescent were less eager to play as narrators, possibly due to the social pressure of a public performance.

6.4. Narrative potential during all three field trials

To explore the narrative potential of Props, we transcribed and translated each story into English. Most stories came from field trials 2 and 3 held in CAVE, where spoken narrative was prevalent. Although word clouds are only a crude representation of such short stories and tell nothing of the actual story line, they do reveal the occurrences of Props items that are encircled in Fig. 8. Only nouns were taken into account and words with at least two occurrences per story were included in the word clouds. Separate stories are shown as their own clouds.

The stories had some observable differences that enlighten the narrative potential on those trials. There were more structured stories told in trials 2 and 3 in CAVE. Spoken narrative was more prevalent during those trials as well (Table 2).

6.5. Enjoyment during all three field trials

The participants’ perceived enjoyment of the storytelling events was assessed from the questionnaire data. Table 7 shows the distribution of the adolescents’ responses to the statement “I enjoyed the event and would like to try this again”. Both adolescents’ and adults’ perceived enjoyment was at the upper end of the scale. Adolescents found storytelling in CAVE a more enjoyable experience than in the conference room. We see that CAVE was more conducive environment for enjoyable storytelling than the conference room (See Table 8).

We also assessed the participants’ enjoyment of the events from the video recordings by interpreting laughter by at least two participants as an emotional cue suggesting enjoyment. The time used

Table 4
The adults’ responses to statements on presence and co-presence on 7-point Likert-scale (1 = completely disagree . . . 7 = completely agree).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Participant ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was part of a story or a play</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>When the event ended I felt like I returned to reality</td>
<td>7 7 3 7 6 6 6</td>
</tr>
<tr>
<td>When I saw the stage I felt like I stepped into a scene</td>
<td>7 3 2 5 5 2 5</td>
</tr>
<tr>
<td>At times I thought I heard sounds from the game</td>
<td>7 3 2 3 4 1 3</td>
</tr>
<tr>
<td>I was an outsider during the event</td>
<td>3 3 2 1 2 1 3</td>
</tr>
<tr>
<td>Other participants affected my behaviour</td>
<td>5 6 7 3 6 7 4</td>
</tr>
<tr>
<td>I was aware of the presence of others during the event</td>
<td>6 3 7 6 5 7 6</td>
</tr>
</tbody>
</table>

Table 5
Observed occurrences of interactions that affected storyline.

<table>
<thead>
<tr>
<th>Field trial: adolescent + Conference room</th>
<th>Field trial: adolescent + CAVE</th>
<th>Field trial: adults + CAVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net duration of storytelling</td>
<td>1 min 10 s</td>
<td>20 min</td>
</tr>
<tr>
<td>Narrator → Props stage</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Prop master → Props stage → Narrator</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Prop master → Props stage</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 6
The number of times different roles were taken.

<table>
<thead>
<tr>
<th>Role</th>
<th>Field trials 1 &amp; 2: adolescents</th>
<th>Field trial 3: adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Prop master</td>
<td>68</td>
<td>9</td>
</tr>
<tr>
<td>Actor</td>
<td>77</td>
<td>0</td>
</tr>
<tr>
<td>Narrator</td>
<td>36</td>
<td>37</td>
</tr>
</tbody>
</table>

Fig. 8. Word cloud of selected stories, the adults’ stories on top and the adolescents’ stories at bottom.
for introducing Props and warm up play were excluded. There were not enough stories told in the conference room to make a valid assessment for this. The data from both CAVE field trials in Table 9 alludes that the adolescent enjoyed the event more.

### 7. Discussion

Our data shows clearly that the interaction from props and prop masters to narrators dominated storytelling, making this direction of influence the main channel of agency. However, allowing the participants to rotate through different roles even out their relative overall storytelling potential and enhances the meaningfulness of their experience. The predefined and fairly small inventory of props obviously both constrained and steered narrative in particular directions. However, the narrators came up with innovative ways to combine and re-appropriate the props to give them new significance. We observed that the narrators were equally likely to ignore and take into account the changes in the Props scene. Narrators have great freedom in telling their stories; they can ignore the cues given by prop masters or morph their meaning to suit their own agenda; and they can introduce new imaginary characters. For example, the little red riding hood was used in a warm up story during one early test session, but an important element was missing from inventory, the wolf. The inventory does have, however, a walrus that was swiftly re-appropriated to serve as a wolf, having fitting credibility to the notion of “What big teeth you have”. Adolescent narrators took the prop masters' cues to their heart. Their stories, while otherwise imaginative, often started with a description of the Props scene, followed by a story that contained almost all the prop masters’ suggestions. Adult narrators’ stories started similarly, but they seemed to be more independent of props inventory.

The familiarity of the participants with the inventory and interface of Props was a significant factor in the interaction between prop masters and narrators. In the pilot study the children favoured easy options such as the random button that the adolescent used seldom and the adults barely at all. Although the adult prop masters were not familiar with the Props inventory, apart from the glimpses they got during the warm up play, they were still able to contribute to the storytelling, something that can be further enhanced by improving the user interface (UI) of Props. To quote one of the participants: “Yes, the user interface is nifty and small, but to react fast one should be able to open all the prop windows at the same time and see all the items there with one glance”. One obvious improvement to the UI is to make it easier and faster for the prop masters to react and modify the scene.

Our data suggests that setting does have an effect on enjoyment and therefore on the meaningfulness of the participants’ experience. There was a notable difference on how the adolescents assessed their enjoyment at the two locations. Guidance did not seem to be the reason for this. In the conference room the guide instructed the participants to take bigger poses and sit down more frequently than the guides in the CAVE. Furthermore, acknowledging that there is a link between action and the sense of presence [43], one might speculate that the heightened enjoyment of the event resulted from the CAVE providing a more immersive setting. This in turn improved the stories, i.e. added to the narrative potential of Props. Still, most participants in all trials, even the adolescent playing Props in the conference room, reported that they enjoyed the storytelling event.

Nevertheless, in the future we seek to create even more immersive settings by adding stereo or 3D audio to the Props inventory [44]. Further, we will allow remote participation in storytelling. In field trial 3 the game scene was hosted on a cloud server thus it would have already been possible to have remote participants to follow the game scene from their PCs. This opens up interesting research directions for studying how the spatial and virtual distance between players affects the social dimensions of collaborative storytelling.

We assessed Props with the Church-Murray aesthetics of VEs. The main difference to the environments assessed with the model previously is the high level of independence that the participants have in constructing the narrative, i.e. the authoriality of the agency they have. Our exploration into the form and direction of the agency provided by Props remained undeniably shallow, but points to an interesting direction for future research. Upcoming trials with Props should shed further light on what aesthetic pleasures and forms of agency are particular for mediated collaborative storytelling in hybrid spaces.

### 8. Conclusion

Our study shows that immersive setting, guidance and the available inventory of visual elements have significance to the narrative potential and the enjoyment of participants in storytelling events mediated by a hybrid storytelling system like Props. Their significance was limited, though, and they only slightly affected the enjoyment that the participants got from collaborative storytelling. The agency displayed by different age groups during improvised storytelling varied. The younger participants seemed to prefer easier choices and fast shifts in the resulting narrative. Yet, the same storytelling system was able to cater for also older participants in an enjoyable manner that resulted in a meaningful narrative.
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