

# Storytelling with Objects to Explore Digital Archives

David Blezinger <sup>1</sup>

<sup>1</sup> Faculty of Engineering and  
Information Technology  
81 Broadway  
Ultimo NSW 2007, Australia  
+61 2 9514 8967

Elise van den Hoven <sup>1,2,3,4</sup>

<sup>2</sup> Department of Industrial Design  
Eindhoven University of Technology  
Eindhoven, Netherlands

elise.vandenhoven@uts.edu.

au

<sup>3</sup> ARC Centre of Excellence in  
Cognition and its Disorders  
Macquarie University  
Sydney, Australia

<sup>4</sup> DJCAD, University of Dundee  
Dundee, United Kingdom

## ABSTRACT

Finding media in archives is difficult while storytelling with photos can be fun and supports memory retrieval. Could the search for media become a natural part of the storytelling experience? This study investigates spatial interactions with objects as a means to encode information for retrieval while being embedded in the story flow.

An experiment is carried out in which participants watch a short video and re-tell the story using cards each of which shows a character or object occurring in the video. Participants arrange the cards when telling the story. It is analyzed what information interactions with cards carry and how this information relates to the language of storytelling.

Most participants align interactions with objects with the sentences of the story while some arrange the cards corresponding to the video scene. Spatial interactions with objects can carry information on their own or complemented by language.

## CCS Concepts

**Human-centered computing** → **Interaction Design** → **Interaction design process and methods** → **User centered design**

## Keywords

Interaction Design; Storytelling; Objects; Spatial; Retrieval; Digital Archives; Language

## 1. INTRODUCTION

Large collections, poor naming of folders and poor organization of folder structure make it difficult to find media in personal archives, and more sophisticated annotation and search features are seldom used [28]. Photo sharing and storytelling in a social context on the other hand can be fun and is a common way of keeping memories alive. Photos can trigger stories and a story can lead to the search for other photos [2]. Through the development of digital prototypes such as 4Photos [3] and StoryTrack [2] it was investigated how stories evolve around photos, making interactions with photos an integral part of a social remembering experience.

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This study investigates storytelling with objects as a possible means to embed interactions which carry information relevant for retrieval from a digital archive in the natural flow of a conversation. Ullmer and Ishii [26] have mentioned how configurations of persistent physical objects can correspond to a state within a digital system and how this can be used to access digital information. The configuration of objects which represent entities the users are familiar with, such as people and locations, could be used to retrieve personal media from digital archives. Configurations could represent simple statements such as “Kate, Michael and the dog on holiday in Italy”, or objects could be used to tell longer stories which contain more specific information about the photos the user wants to retrieve.

Within the context of supporting better remembering experiences through external remembering [12] we aim to inform the design of media retrieval systems at the level of individual interactions [15]. By making interactions for media retrieval a natural part of the user’s storytelling and social conversations we try to reduce design interference into the remembering experience as much as possible.

Storytelling with objects could be used in social media applications or in co-located social situations. Developing a full application and testing it in a social situation is challenging as many factors need to be considered such as the social dynamics of conversations and the interplay between storytelling with objects and memory retrieval. We choose to narrow the focus of this study on the dynamics of storytelling with objects as this can form a basis for understanding how interactions with objects which carry retrieval relevant information can be naturally embedded in storytelling. We analyze interactions with physical objects to inform digital interactions. In arranging objects during storytelling the user changes the spatial configuration and thus the state of an external representation. Interactions with external representations can be seen as “a back and forth process: a person alters the outside world, the changed world alters the person and the dynamic continues” [18].

An experimental study is carried out during which the participant watches a short video and re-tells the story using cards each of which shows a person or an object occurring in the video. When telling the story the participant arranges the cards to support verbal storytelling. The information carried by spatial interactions with cards and resulting configurations is analyzed in relation to the language of storytelling. We assume that participants will arrange the cards to represent locations of people and objects within a scene or configure them in alignment with the story flow and the language of storytelling.

In the following sections we review literature on storytelling with photos and links between interactions with objects and language,

introduce the methodology of the experiment, and we present and discuss the results of a thematic analysis.

## 2. RELATED WORK

### 2.1 Storytelling with Photos

To conceptualize storytelling with photos as a conversational and organizational process we review related literature.

In a study of photo use in social interactions and remembering in PC owning families Frohlich et al. [9] observe how people use photos for storytelling and reminiscing in co-present sharing situations. Storytelling talk serves to share memories with others who were not present at events shown on photos while people use reminiscing talk to “find” shared memories together. Photos serve as a shared visual reference which enables people to question the visual material collaboratively and reconstruct memories together.

The StoryTrack device [2] uses the photo story as an organizational metaphor. In transferring the principle of the physical photo album to a digital solution the story becomes a vehicle to organize digital photos, blending aspects of chronological orderings and user-created groupings such as folders or directories in a file system” [2]. StoryTrack enables users to create photo stories collaboratively as well as to browse through photos spontaneously while telling a story. However, the distinction between authoring and viewing stories means that organizing photos into a story is considered a separate activity from viewing the photos and telling the story.

In 4Photos [3] and Cueb [11] the structure of the story is not represented externally and rather than relying on a pre-authored story the story emerges from social interactions between the participants of a conversation and photos displayed by a device. As a centerpiece 4Photos [3] becomes part of the conversation around the dinner table. It is designed to affect the social dynamics of talk, “distributing both responsibility and opportunity for conversational control away from a single person” [3]. The conversation is only partly centered around the photos which makes the device shift in and out of the conversation. A random selection of photos from a subset becomes the starting point of new conversations some of which are about topics which would not usually be discussed. In Cueb [11] the random display of photos serves as a facilitator of social communication. Cueb displays photos from both parents’ and teenagers’ lives. Teenagers learn more about parents when they were young, comparing parents’ experiences such as parties with their own experience. Old photos trigger memories and initiate conversations. A trigger or cue is a “piece of information, a piece of mind, or an experience” [14] which facilitates memory retrieval, “bringing to consciousness an unconscious state” [14] and aiding memory to retrieve details which are not remembered otherwise. A cue can trigger a memory which a family member then communicates about [11].

In summary storytelling with photos facilitates:

- Sharing memories with others
- Finding shared memories together
- Questioning and contextualizing a story
- Structuring conversations
- Social communication

### 2.2 Links between interactions with objects and language

To understand how the activity of arranging objects may relate to the language of storytelling we review related literature, and we

introduce SAA notation as a means to describe both sentential and visuospatial representations.

The language of storytelling is complemented by the visual language of photos. Language can be seen as an expression of thought [8] [10]. Interactions with photos during annotating and storytelling can be described as part of a process of externalizing thought. Storytelling externalizes memories in sentential form whereas photos provide an external representation “in which information is indexed by two-dimensional location” [19]. An understanding of commonalities between sentential and visuospatial representations could contribute to an understanding of interactions with photos during storytelling and facilitate an integrated analysis of information within language and photos.

Spatial relations between objects in visual representations can carry information. Information is not only present in objects but also in spatial relations among them. The spatial information in graphics is closely related to mental representations. “Spatial relations, such as distance and directions, may represent literal spaces – on a smaller scale – or metaphoric spaces” [25]. Both sentential representations in which information is distributed sequentially, and visual representations in which information is spatially distributed can be described as symbolic representations using the Symbol-Argument-Argument (SAA) notation [8]. SAA can be used to model human language and mental representations [8]. It represents language in form of relations. A sentence such as “John loves Mary” can be described as a relation in which “loves” forms a symbol to which “John” and “Mary” are bound as arguments. The position of the arguments in the relational expression determines their relational roles. “John is bound to the *lover* role by virtue of appearing in the first slot after the open parenthesis, and Mary to the *beloved* by virtue of appearing in the second slot” [8]. SAA notation can also be applied to visuospatial representations such as diagrams or photos. “In a labeled graph the top node (of the local sub-graph coding “John loves Mary”) represents the *loves* relation” [8]. When arranging objects during storytelling their spatial relations change. SAA can be used to describe and analyze spatial interactions with objects during storytelling and their potential relationships to the language of storytelling.

## 3. METHODOLOGY

An experiment is carried out to investigate how participants place and configure objects when they tell a story. We assume that participants place an object when they refer to it in language. Objects may be configured to represent relations present in the language of storytelling [8] or to spatially represent the scene. The use of objects to represent relational statements rather than just an individual scene could be beneficial for media retrieval as it can describe wider contexts, e.g. “Kate, Michael and the dog on holiday in Italy.”

### 3.1 Participants

An experimental study is carried out with 15 participants. Participants are healthy adults of which 3 are women and 12 are men. 14 participants are aged between 18 and 35 with an average of 25 years, 1 participant is older than 35 years. All participants are fluent English speakers and have no significant visual impairment.

### 3.2 Procedure

A 2-minute video consisting of four sequences (Fig.1) is shown to the participant. After watching the video, the participant takes a one minute break. Cards are laid out on a table in front of the seated participant each of which shows a photo of a character or

object involved in the video (Fig. 2). The participant is asked to retell the story as remembered from the video. The participant is told that she can move the cards to and from a surface (stage) in front of her (Fig. 2), gesture and point at the photos. After the experiment is completed each participant fills in a questionnaire.

### 3.3 Video Clip

Storytelling based on a video is preferred to storytelling based on autobiographical memories because it creates a common shared reference which makes storytelling and interactions more comparable between participants. This study puts its focus of analysis at the level of interactions which correspond to individual sentences of the story, and we assume that the choice of video material based on personal memories of participants would not influence the results at this level of analysis.

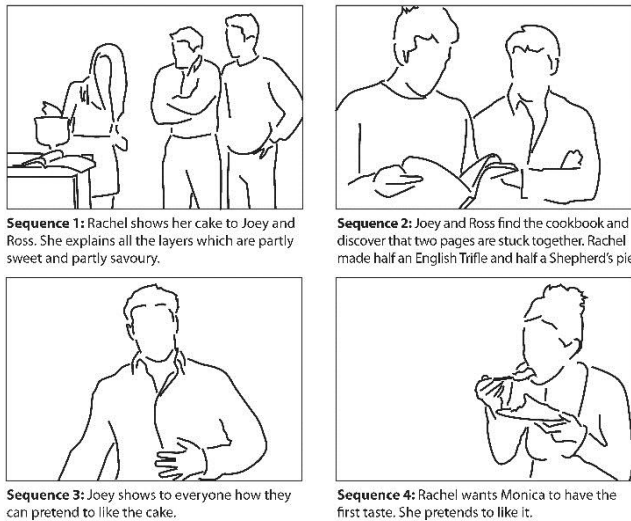


Fig. 1. Four video sequences (drawn due to copyright)

For the 2-minute video four short sequences are chosen which together form a simple story. Characters and objects involved vary in each sequence. The chosen video is selected to be entertaining and funny which might distract from perceiving the experiment as a serious task. The story consists of four scenes in which a different combination of characters contributes to the overall plot of the story (Fig. 1).

To tell the story the participant needs to remember who is present in each scene, how they interact and contribute to the overall story. This is assumed to provide enough elements to put a challenge on memory but to be simple enough to recall most key elements and allow comparison between participants.

The video is an extract from the TV series “Friends” whose latest episode was first broadcast 10 years ago. Thus it can be expected that most participants are familiar with the series and its characters but do not remember the particular scene they are shown. Familiarity with the characters may facilitate identifying the characters when telling the story using the cards. An evaluation of the questionnaire did not suggest a relationship between participants’ knowledge of the series and their performance in the experiment.

### 3.4 Materials

The area of interaction is sized to be within easy reach of the participants’ arms (Fig. 2). A white rectangular surface (stage) on which the participants can arrange the cards to tell the story is

sized accordingly. The boundary of the surface is clearly marked in dark grey color.

A total of 8 cards showing a character or object occurring in the video are created based on a choice of characters and objects considered relevant to the story. The cards are sized to be convenient to grasp and small enough to leave space for interaction on the rectangular surface. Each of the cards shows the visual appearance of the person or object it depicts while not showing any background or facial expression which would relate to a particular scene. The name of the person or object is printed on each card to allow consistent reference to cards in the language of storytelling across participants. As the cards offer an iconic reference [26] to a character or object involved in the video they can be described as “iconic cards”.

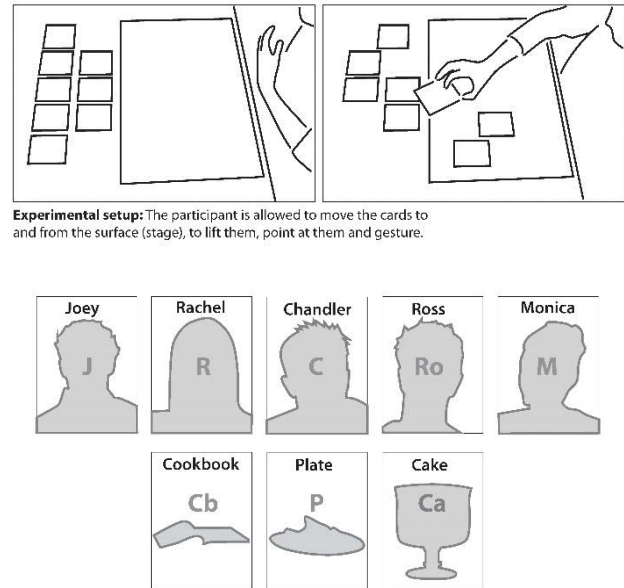


Fig. 2. Experimental setup and cards (drawn due to copyright)

### 3.5 Questionnaire

The questionnaire captures general information about the participant including educational background and level of familiarity with the TV series and the particular episode the video is extracted from.

### 3.6 Analysis

A combination of interaction analysis [15] and thematic analysis [5] is carried out to understand how spatial interactions with cards relate to storytelling.

The storytelling and interactions of participants are video recorded, interactions with photos are coded from the videos. Coded interactions include moving a card to the stage (TO), moving a card on the stage (ON) and removing a card from the stage (FROM) (Fig. 3). In addition, interactions with cards at their spatial position are coded which include lifting a card (UP), touching a card (TOUCH), pointing at a card (POINT). Gesturing occurs partly in relation to cards and partly in free space (GESTURE).

Coding of interactions with cards serves as a basis for the identification of themes which summarize underlying principles by which participants organize the cards. The focus of analysis is on relationships between spatial interactions with cards and the language of storytelling. Using thematic analysis and detailed

analysis of interactions commonalities and variance between participants are described. A comparison between themes shows that patterns within different themes can be related to similar underlying relationships between language and interactions.

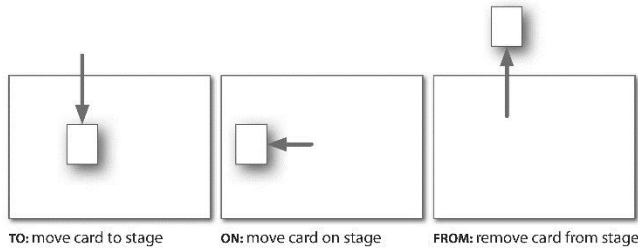


Fig. 3. Spatial interactions

## 4. RESULTS

The time it took participants to retell the story using the cards ranges from 45 seconds (P9) to 3 minutes 43 seconds (P12), with an average of 1 minute 52 seconds.

### 4.1 Spatial Interactions

All participants are moving the cards to the stage and purposefully arrange them to update the scene and accompany/complement the storytelling.

Apart from TO (9.6/participant), ON (6.9/participant) and POINT (4.7/participant) are the most frequent interactions. Card placements on the stage (TO, ON), are differentiated by placement on empty space (1.8/participant) and in relation to another card (6.5/participant). For each interaction, including non spatial interactions, it is coded whether the interaction accompanies storytelling (the interaction does not represent any information that is not already present in the storytelling of the participant) or whether the interaction complements storytelling (the interaction carries information which is not explicitly referred to in storytelling). Interactions mostly accompany storytelling (83%), interactions which complement storytelling are mostly spatial.

### 4.2 Thematic analysis

The coding of spatial interactions with cards in relation to storytelling allows to identify different themes. Themes are defined in several iterations and narrowed down to five main themes – relational placement, meaningful placement, spatial positions, change of scene and story cue.

#### 4.2.1 Summary of themes

Placing cards on the stage accompanies storytelling. When the story refers to a character or object which is represented by a card the card is moved to the stage. On the stage, the card is placed in relation to other cards on the stage. This relational placement corresponds to the structure of the sentence (relation) through which the story is told. “Rachel talking to Ross about the cake” (Fig. 4.1) leads to a different spatial configuration than “Rachel and Joey and Ross and the cake” (Fig. 4.3). Similar observations were summarized in the theme ‘relational placement’. In some cases the placement of cards does not clearly correspond to the sentences used in storytelling, and while it appears to relate to the meaning carried by the story the meaning cannot be unambiguously identified. Such interactions form the theme ‘meaningful placement’. Participants sometimes use the same spatial position for two consecutive cards, e.g. by replacing a card with another or by swapping two cards. Such cases form the theme “spatial positions”. When an interaction with a card appears

to trigger a memory the interaction is part of the theme “story cue”, and when the position of cards is changed at the start of a new scene it is coded as part of the theme “change of scene”.

In the following sections the five themes are introduced through examples from different participants. The most frequently observed theme “relational placement” will be introduced last as it also refers to other themes in which correspondence of interactions to the sentences of storytelling can be observed. In addition to the introduction of the five themes different strategies of storytelling are observed which lead to a different focus in creating consistency between cards and storytelling.

#### 4.2.2 Meaningful placement

Why is the cookbook positioned in the middle beneath Joey and Ross when saying “then Ross looked in the cookbook” (P5)? Does it represent the position of the cookbook in the scene, or does it implicitly represent the statement “Joey and Ross are looking at the cookbook”? In the statement “then they are sitting all together at the table” why does participant 4 place Joey, Ross and Chandler in the top row, Rachel and Monica in the bottom row? It could indicate active and passive roles of characters in the story. Creating a top and bottom row could also be an attempt to correspond to the scene in which they are sitting around the table.

#### 4.2.3 Change of scene

The interactions are mostly uncommented. Participant 2 moves Ross and Joey higher while Rachel and the cake are lowered which may be used to highlight Ross and Joey as the center of attention in the current scene. In other examples cards are moved to the center of the stage after other cards have been removed (P4, P3). This could put the cards in the center of attention or just be centering the cards as the new scene starts.

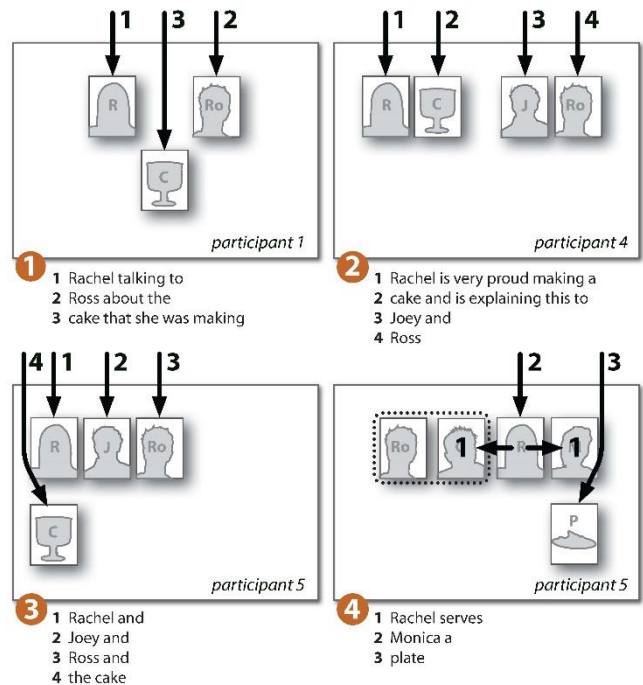


Fig. 4. Spatial interactions accompany the story

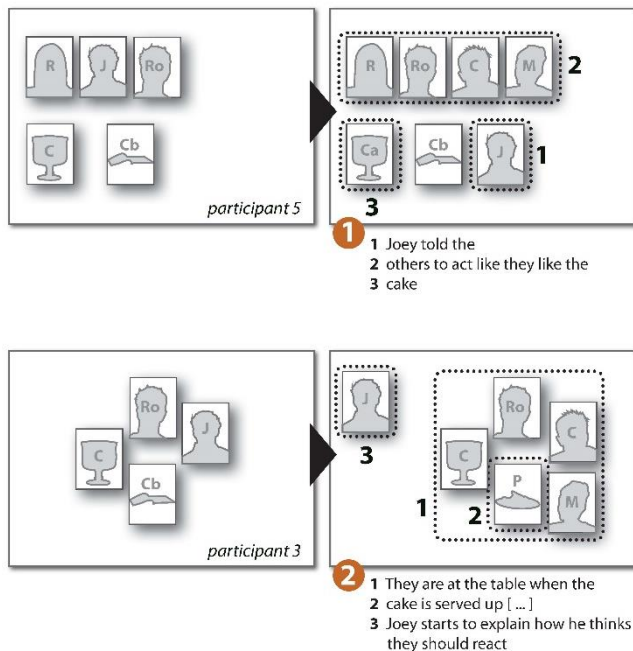
#### 4.2.4 Story cue

Participant 1 reaches out to move Rachel onto the stage when he remembers an additional detail of the story: “Then Rachel came ... oh, and Chandler said that he wasn’t paying for those sort of acting classes anymore”. Participant 2 remembers what happens

in the next scene while touching the card “plate”. The participant hesitates before saying “when she is about to serve *it*”. The plate is part of the sentence, thus the card may serve as a visual cue which helps remembering the sentence. When looking at the arrangement of cards and saying “says it to the rest” another participant (P4) notices that Rachel is not part of the rest which leads to Rachel’s removal from the group of cards. The arrangement of cards is inconsistent with the participant’s memory of the rest” and thus brings the memory to consciousness that Rachel is not part of the rest.

#### 4.2.5 Spatial positions

In Fig. 4.4 two cards are moved to free a position which puts the cards in line with the sentence “Rachel serves Monica a plate”, in Fig. 5.2 the configuration of cards is made consistent with the sentence “Joey starts to explain how he thinks *they* should react” by exchanging Joey and Chandler. The exchange leads to Joey being free while Chandler becomes part of the group, thus representing the relational roles “Joey” and “they” correctly. A card can also be replaced with another card when the scene is changing. In Fig. 5.2 “they take the cookbook” changes to “they are at the table with the cake served” by replacing the cookbook with the plate. In another example the sentence “Rachel went away and Joey came in” (P1) is accompanied by replacing Rachel with Joey. This could be symbolizing Joey taking Rachel’s position in the scene or represent the implicit statement “x is in the scene” in which Rachel is replaced by Joey.



**Fig. 5 Modifying existing configuration to represent a new statement**

#### 4.2.6 Relational placement

The particular structure of sentences used in individual participants’ storytelling corresponds to the positioning of cards (Fig. 4). “Rachel talking to Ross about the cake” (Fig. 4.1) leads to a different spatial configuration than “Rachel and Joey and Ross and the cake” (Fig. 4.3). It can also be observed in several participants (P1, P2, P3, P5, P7, P8, P10, P11, P14) that cards are moved to free space for another card in order to enable placing a card in relation to another card to correspond to a sentence (e.g. Fig.4.4).

Participants rearrange cards to maintain consistency between the arrangement of cards and the sentences of storytelling, which is observed across themes. Inconsistencies between cards and storytelling prompt the memory of the correct configuration (P4). Participants remove inconsistencies, e.g. by exchanging cards or removing cards. In the later scenes the stage becomes more populated and thus the freedom of where to place new cards becomes constrained by the present configuration of cards on the stage. Configurations of cards are modified to correspond to the story (Fig.5). 5 participants (P3, P5, P8, P12, P13) place the cards consistent with “Joey” and “the others” when talking about the scene in which Joey suggests the others should pretend to like the cake (e.g. “Joey told the others”, “Joey starts to explain how he thinks they should react”, “Joey informs the rest of them”). 6 participants (P4, P5, P7, P8, P12, P13) place the cards consistent with “Rachel”, “plate” and “Monica” when talking about the scene in which Rachel hands the cake to Monica (e.g. “Rachel hands Monica a plate with the food”, “Rachel offers the plate to Monica”, “Monica is asked by Rachel to eat the food”).

To render the cards consistent with a sentence each participant needed to reconfigure some of the cards. Based on the configuration of the previous scene which was different across participants the resulting spatial order of cards which was used to match the above sentences was also different. This difference in actual positions of the cards makes it unlikely that the cards are arranged in an attempt to recreate the spatial order within the actual scene as remembered from the video. All resulting configurations are consistent with the sentences they accompany in storytelling, thus the effort to reconfigure cards is likely to be an attempt to match the language of storytelling.

Spatial interactions with cards vary in the degree at which the information that is carried by the interaction is made explicit by the interaction itself. In the present setup and its possible spatial interactions two types of relations can be differentiated. In TO (‘enters the scene’) and FROM (‘exits the scene’) the spatial interaction itself represents its symbolic meaning while ON needs the story to accompany the interaction, e.g. “Rachel serves Monica a plate”.

#### 4.2.7 Storytelling Strategies

As observed above in most participants the positioning of cards corresponds to language and is consistent with the sentences used in storytelling. However, there are also cases in which consistency of cards with language is not maintained. Different strategies of using the cards can be observed which lead to a different focus in creating consistency. The cards can be used to complement the story rather than matching it, the cards can be laid out corresponding to the scene rather than consistent with language, and the order of cards can drive the sentences used in storytelling. In all participants it can be observed that the positioning of cards in relation to the language of storytelling is consistent with the strategy the participant uses.

Participant 10 lays out the cards corresponding to the scene before telling the story. Positions of cards are not always consistent with language. Several participants (P9, P11, P15) use a strategy in which they place each card on the stage in a single sequence, and the order in which they refer to the cards in the story closely follows this sequence. Within this strategy two types can be differentiated. Two participants (P9, P15) position the cards while telling the story, P11 positions the cards before telling the story.

## 5. Discussion

The results from this study show a strong link between the language of storytelling and spatial interactions in arranging cards. Most participants keep information in the sentences of the story consistent with information carried by spatial interactions and resulting configurations. This suggests that ordinary people have the ability to interact with objects as part of the natural flow of their speech when telling a story. This could be exploited through an interactive language which embeds interactions with a digital system into the flow of the user's speech.

Other storytelling strategies such as arranging cards to represent the scene were also observed but occurred much less frequently. However, a modified experimental setup which affords better representation of the scene may lead to different results.

Spatial interactions can carry information in different ways. Most explicitly they show who is present in the scene, and when people or objects enter or leave the scene. Interactions can be described using SAA [8]. The symbol "enters" is represented by a card being put onto the stage, thus the symbol is being represented by a spatial interaction only. Such interactions provide a spatially unambiguous symbolic representation. The spatial containment relationship (person enters scene) within the interaction is also consistent with the spatiality in the scene it represents. In sentences which are represented by arranging cards in relation to each other, such as "Rachel is talking to Ross" the symbol "talking" is represented by the interaction of placing Rachel and Ross next to each other while expressing the sentence through language. Such interactions provide more flexibility in representing any meaning carried by a story but they rely on language to define their symbolic meaning. If language is used to represent symbolic meaning in a design application it needs to be defined whether and how language is visually represented, e.g. through a node link graphic in alignment with SAA notation.

The findings of this study could be used for the design of retrieval systems on the basis of interactions which integrate naturally with the user's speech. Information for retrieval of media from a digital archive includes people, activity and location. When using storytelling with objects to retrieve photos from a digital archive the beginning of the story is open and the order in which the story defines information for retrieval is flexible. A story about Mark windsurfing in Spain could equally start from Mark's windsurfing experiences, Mark's holiday experiences in Spain or windsurfing in Spain. As the story develops information for retrieval builds up. A limited set of persistent objects can be configured in various orders to tell different stories and represent situation specific meaning.

The object configurations the user generates when telling a story could lead to media suggestions from which the user can select. This cycle of storytelling and media selection would contribute to the dynamic of storytelling and offer many different pathways for exploring digital archives. Over time the user makes new experiences and adds media to the archive which opens further possible pathways for exploration. Introducing a degree of randomness in media suggestions would allow the interaction to be partly driven by storytelling and partly by the encounter of unexpected media. Giving up part of the control to the system may also support a more serendipitous experience [20].

Objects for storytelling and media retrieval could be implemented as tangibles which also become meaningful artifacts in the user's home environment. Objects can serve as "entry points" to stories by triggering memories [14] which become the starting point of a conversation [11]. In a social context objects can also support

collaborative storytelling – different people can contribute to selecting and arranging objects while telling a story.

When using physical objects there is a limitation in the number of objects one can simultaneously have available for interaction. A screen based user interface would support an unlimited number of objects. The use of language would offer more information for media retrieval than the use of objects alone, thus it could be considered how information present in the story could be used for retrieval.

The development of a digital prototype of a retrieval system using storytelling with objects could serve to contextualize and test the findings of this study in social situations, with the aim of using storytelling with objects to collaboratively reconstruct memories and retrieve media from digital archives. The prototype would be tested on the basis of personal memories of participants instead of a video.

A user study could serve to analyze the combined dynamics of storytelling with objects and retrieved media. The analysis could include the use of the system for spontaneous storytelling and search of particular media, and how objects serve as entry points into a new story. Mechanisms of media retrieval using objects and degree of randomness of retrieved media could be evaluated with regards to remembering experiences [12] of a person or group of people.

## 6. Conclusion

An experiment is carried out to investigate how spatial interactions with cards are embedded in storytelling and carry information which could be used to retrieve personal media. Participants watch a short video and re-tell the story using photos each of which only shows a character or object occurring in the video. Participants configure the cards when telling the story which makes relationships between language and interactions with photos explicit.

Most participants choose to arrange the cards consistent with the sentences of the story, however other storytelling strategies were also observed, such as positioning of cards consistent with positions of people or objects in the scene, or placing the cards in a sequential order to tell the story.

Spatial interactions can carry information on their own or complemented by the language of the story. Storytelling with objects allows to start stories at different points and gives flexibility in building up information for media retrieval. A limited set of persistent objects can be configured in various orders to tell different stories and represent situation specific meaning. In a digital application using storytelling with objects different parts of the story could be preserved and viewed next to each other. A degree of randomness in the selection of objects for storytelling and in the retrieved media could be introduced in order to encourage spontaneous storytelling and invite the user to explore new stories.

Interactions which accompany language could also be used in other applications such as interactive graphics for presentations, reasoning with interactive diagrams and applications for collaborative problem solving.

## 7. ACKNOWLEDGMENTS

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## 8. REFERENCES

- [1] Apted, T., Kay, J. and Quigley, A. 2006. Tabletop Sharing of Digital Photographs for the Elderly. In *Proceedings of CHI* (Montreal, Quebec, Canada, April 22-27, 2006), 781-790. DOI = 10.1145/1124772.1124887.
- [2] Balabanovic, M., Chu, L. L., Wolff, G.J. 2000. Storytelling with Digital Photographs. In *Proceedings of CHI* (The Hague, Netherlands, April 1-6, 2000), vol. 2, Issue 1, 564-571. DOI = 10.1145/332040.332505.
- [3] ten Bhömer, M. Helmes, J., O'Hara, K. and van den Hoven, E. 2010. 4Photos: A Collaborative Photo Sharing Experience. In *Proceedings of NordiCHI* (Reykjavik, Iceland, October 16-20, 2010), 52-61. DOI = 10.1145/1868914.1868925.
- [4] Blezinger, D., Fatah gen. Schieck, Ava and Hoelscher, C. 2013. Unifying Conceptual and Spatial Relationships between Objects in HCI. In *Proceedings of HCI International* (Las Vegas, USA, July 21-26, 2013) Towards Intelligent and Implicit Interaction, Vol. 8008 LNCS, 10-18. DOI = 10.1007/978-3-642-39342-6\_2.
- [5] Braun, V. and Clarke, V. 2006. Using thematic analysis in psychology. In *Qualitative Research in Psychology*, 3, 2, 77-101 (April 2006). DOI = 10.1191/1478088706qp063oa.
- [6] Conway, M.A. and Pleydell-Pearce, C.W. 2000. The Construction of Autobiographical Memories in the Self-Memory System. In *Psychological Review*, 107, 2 (April 2000), 261-288. DOI = 10.1037//0033-295X.
- [7] Crabtree, A., Rodden, T. and Mariani, J.. 2004. Collaborating around Collections: Informing the Continued Development of Photoware. In *Proceedings of CSCW* (Chicago, USA, Nov 6-10, 2004), 396-405. DOI = 10.1145/1031607.1031673.
- [8] Dumas, L.A.A. and Hummel, J.E. 2005. Approaches to Modeling Human Mental Representations: What works, What Doesn't and Why. In, Holyoak, K.J., Morrison, R.G. (Eds.) *The Cambridge Handbook of Thinking and Reasoning*, 73-91. New York: Cambridge University Press.
- [9] Frohlich, D., Kuchinsky, A., Pering, C., Don, A. and Ariss, S. 2002. Requirements for Photoware. In *Proceedings of CSCW* (New Orleans, USA, Nov 16-20, 2002), 166-175. DOI = 10.1145/587078.587102.
- [10] Gleitman, L. and Papafragou, A. 2005. Language and Thought. In, Holyoak, K.J., Morrison, R.G. (Eds.) *The Cambridge Handbook of Thinking and Reasoning*, 73-91. New York: Cambridge University Press.
- [11] Golsteijn, C. and van den Hoven, E. 2011. Facilitating parent-teenager communication through interactive photo cubes. In *Personal and Ubiquitous Computing*, 17, 2 (April 2011), 273-286. DOI = 10.1007/s00779-011-0487-9.
- [12] van den Hoven, E. 2014. A future proof past: Designing for remembering experiences. In *Memory Studies*, 7, 3 (July 2014), 370-394. DOI = 10.1177/1750698014530625.
- [13] van den Hoven, E. and Eggen, B. 2009. The Effect of Cue Media on Recollections. In *Human Technology*, 5, 1 (Jan.09), 47-67. DOI = 10.17011/ht/urn.20094141410.
- [14] van den Hoven, E. and Eggen, B. 2014. The Cue is Key. In *Zeitschrift für Psychologie*, 222, 2 (Jan. 2014) 110-117. DOI: 10.1027/2151-2604/a000172.
- [15] Jordan, B. and Henderson, A. 1995. Interaction Analysis: Foundations and Practice. In *The Journal of the Learning Sciences*, 4, 1 (Jan. 1995), 39-103.
- [16] Kirsh, D. (1995) The intelligent use of space. In *Artificial Intelligence* 73 (Feb. 1995), 31-68. DOI = 10.1016/0004-3702(94)00017-U.
- [17] Kirsh, D. 2009. Projection, Problem Space and Anchoring. In N.A. Taatgen & H. van Rijn (Eds.), In *Proceedings of the 31st Annual Conference of the Cognitive Science Society* (Amsterdam, Netherl., July 29 – Aug. 1 2009), 2310-2315.
- [18] Kirsh, D. 2010. Thinking with external representations, in *AI and Society*, 25, 4 (Nov. 2010), 441-454.
- [19] Larkin, J.H. and Simon, H.A. 1987. Why a Diagram is (Sometimes) Worth Ten Thousand Words. In *Cognitive Science* 11 (Jan. 1987), 65-99. DOI = 10.1111/j.1551-6708.1987.tb00863.x.
- [20] Leong, T.W., Howard, S. and Frank Vetere, F. 2008. Choice: Abdicating or Exercising? In *Proceedings of CHI* (Florence, Italy, April 05-10, 2008), 715-724. DOI: 10.1145/1357054.1357168
- [21] Tuck Wah Leong, Wright, P., Vetere, F. and Howard, S. 2010. Understanding experience using dialogical methods: the case of serendipity. In *Proceedings of OZCHI* (Brisbane, Australia, 22-26 Nov. 2010), 256-263. DOI = 10.1145/1952222.1952278.
- [22] Meerbeek, B., Bingley, P., Rijnen, W. and van den Hoven, E.. 2010. Pipet: A design concept supporting photo sharing. In *Proceedings of NordiCHI* (Reykjavik, Iceland, October 16-20, 2010), 335-342. DOI = 10.1145/1868914.1868954
- [23] Scaife, M. and Rogers, Y. 1996. External cognition: how do graphical representations work? In *Human-Computer Studies* 45 (Aug. 1996), 185-213. DOI = 10.1006/ijhc.1996.0048.
- [24] Stenning, K. and Oberlander, J. (1995) A Cognitive Theory of Graphical and Linguistic Reasoning: Logic and Implementation. In *Cognitive Science*, 19 (Jan. 1995), 97-140. DOI = 10.1016/0364-0213(95)90005-5.
- [25] Tversky, B. 2003. Structures of Mental Spaces: How People Think About Space. In *Environment and Behaviour*, (2003) 35, 1 (Jan. 2003), 66-80. DOI = 10.1177/0013916502238865.
- [26] Ullmer, B. and Ishii, H. 2000. Emerging Frameworks for tangible user interfaces. In *IBM Systems Journal*, 39, 3-4 (July 2000), 915-931. DOI = 10.1147/sj.393.0915.
- [27] West, D., Quigley, A. and Kay, J. 2006. Memento: A Digital Physical Scrapbook for Memory Sharing. In *Personal and Ubiquitous Computing*, 11, 4 (April 2007), 313-328. DOI = 10.1007/s00779-006-0090-7.
- [28] Whittaker, S., Bergman, O. and Clough, P. 2010. Easy on that Trigger Dad: A study of long term family photo retrieval. In *Personal and Ubiquitous Computing*, 14 (Jan. 2010), 31-43. DOI = 10.1007/s00779-009-0218-7.
- [29] Zhao, Xuan, Salehi, N., Naranjit, S., Alwaalan, S., Volda, S. and Cosley, D. 2013. The many faces of facebook: Experiencing social media as performance, exhibition and personal archive. In *Proceedings of CHI* (Paris, France, April 27 – May 2), 1-10. DOI = 10.1145/2470654.2470656.