Fostering Virtual Guide in Exhibitions

First Author
University of Author
Authortown, CA 94022, USA
author1@anotherco.edu

Second Author
VP, Authoring
Authorship Holdings, Ltd.
Awdur SA22 8PP, UK
author2@author.ac.uk

Third Author
Fourth Author
Lēkhaka Interaction Labs
Bengaluru 560 080, India
author3@anotherco.com
author4@hchi.anotherco.com

Fifth Author
YetAuthorCo, Inc.
Authortown, BC V6M 22P
Canada
author5@anotherco.com

Sixth Author
Université de Auteur-Sud
40222 Auteur France
author6@author.fr

Seventh Author
Department of Skrywer
University of Umbhali
Cape Town, South Africa
author7@umbhaliu.ac.za

Abstract
Museums are essential to make culture accessible to the mass audience. Human museum guides are important to explain the presented artifacts to the visitors. Recently, museums started to experiment with enhancing exhibitions through mixed reality. It enables cultural exhibitors to provide each visitor with an individualized virtual guide that adapts to the visitor's interests. The effect of the presence and appearance of a virtual museum guide is, however, unclear. In this paper, we compare a real-world guide with a realistic, an abstract, and an audio-only representation of the guide. Participants followed four multimodal presentations while we investigated the effect on comprehension and perceived co-presence. We found that a realistic representation of a virtual guide increases the perceived co-presence and does not adversely affect the comprehension of learning content in exhibitions. Insights from our study inform the design of virtual guides for real-world exhibitions.

Author Keywords
Mixed-reality; virtual avatar; co-presence.

ACM Classification Keywords
H.5.m. [Information Interfaces and Presentation (e.g. HCI)]: Miscellaneous

Figure 1: Composers' busts and paintings including them used as stimuli in the study.

Introduction & Background

Exhibition content can be experienced through a wide variety of media. Visitors traditionally learn through interaction with exhibition guides and other visitors, audio or videos guides, as well as non-interactive media such as exhibition labels. Recently, several museums started using mixed reality (MR) as a new media to enhance visitors' experience in exhibitions [7, 9]. By providing a possibility to view virtual simulations from different perspectives and to interact with them in a real environment, MR creates engaging and motivating learning experience while still enabling social interactions [6, 8, 13].

MR can not only support the augmentation of museum artifacts but can also enhance the learning experience through virtual exhibition guides. As narratives can strongly reinforce the visitors learning and understanding of cultural content in a physical museum [16], and as social interaction is the key to strengthen learning [11], virtual guiding avatars are a promising approach to enhance real-world exhibition experiences. Through personalized virtual guides for individuals and groups, MR can provide time-independent exhibition tours.

Previous work suggests that humans could be better guides than agents [15], which are digital models driven by computer algorithms [2]. It might be supported by human guides' abilities to respond spontaneously and to communicate non-verbally through their body pose as it has been shown that gestures support verbal explanations in teaching [19]. On the other hand, embodied conversational agents [5] as virtual representations of humans through virtual avatars can enhance the social aspect of interaction [12], respond spontaneously in-situ and take advantage of non-verbal communication to support their verbal explanation.

The presence of virtual avatars can affect learning [17]. The design of anthropomorphic virtual guides can have a significant impact on the motivation to engage with exhibition content as avatar realism has been shown to have significant effects on presence and co-presence [10, 18]. An increase in human behavior realism, such as gaze, can cause an increase in co-presence [1]. However, adding visual features of a face can negatively effect mediated communication and cause self-disclosure [20]. Bailenson *et al.* proposed a hybrid realism solution for avatars that maintains high co-presence without lowering self-disclosure, which would be beneficial for distance learning applications [2]. Baylor, on the other hand, pointed out that the appearance of the agent as a social model is a critical factor for its success and that providing a social model from the same in-group as the user is generally advantageous [3]. Furthermore, a human-like voice with appropriate and relevant emotional expressions have a positive impact on learners' motivation and engagement with the learning material [4].

While previous work extensively studied virtual avatars in virtual environments, it is unclear how such avatars should be designed for real-world exhibitions. Therefore, we conducted a study with 16 participants to investigate the effect of a virtual guide on comprehension of the exhibition content and the perception of the guide. We compared a real-world guide with a realistic, an abstract, and an audio-only representation of a virtual guide in a real-world exhibition setting. Results show that the presence and the appearance of a virtual guide do not affect the comprehension of the exhibition content. However, the perceived co-presence is higher for realistic representation than for the abstract or audio-only representations.

Method

To assess the effect of the presence of an exhibition guide and its appearance in the MR environment, we conducted

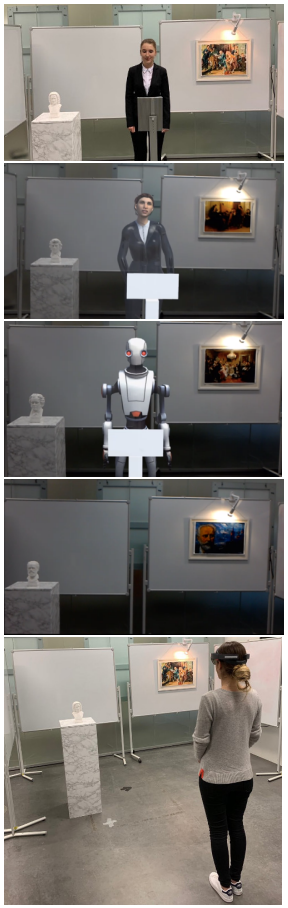

Figure 2: Real, MR-Realistic, MR-Abstract, and MR-Audio conditions. A participant in the MR exhibition.

a controlled experiment. Therefore, we prepared a real-world exhibition room with four short presentations. The presentations were conceptually similar but introduced different content. To present content with different modalities, we selected four classical music composers: Johann Sebastian Bach, Frédéric François Chopin, Franz Peter Schubert, and Pyotr Ilyich Tchaikovsky. For each presentation, we used a bust of the composer, a short piece of music by the composer ("Gottes Zeit ist die allerbeste Zeit (Actus tragicus)", "Polonaise in G minor - Posthumous", "Der Erlkönig", and "Symphony No. 1 Winter Dreams", respectively) and a painting showing the composer in the historical context. Furthermore, we prepared a speech for the guide describing the life and work of each composer. The texts of the speeches were on average 461 (SD = 5.09) words long. For the study, we varied the presence and the appearance of the guide (see Figure 1). Consequently, the guide was presented as a human (*Real*), a realistic avatar (*MR-Realistic*), an abstract robot (*MR-Abstract*), or only by audio (*MR-Audio*).

We systematically varied the realism of the guide resulting in a within-subject design with a single independent variable *Guide*. The independent variable had four levels: Real, MR-Real, MR-Abstract, and MR-Audio. We used two dependent variables. We measured comprehension of the heard speech using multiple choice questions. Furthermore, we measured social presence and the affinity to the guide using the co-presence questionnaire by Poeschl and Doering [14]. We ensured that the texts for the presentations and their questions had a similar complexity through a pilot study with six participants.

We recruited 16 participants (8 female) through our university mailing lists. Their average age was M = 22.75 (SD = 3.38) years. Most participants had a background in IT, and all were university students. 31.25% of the participants reported having experience with MR. Participants received 10EUR for taking part in the study.

As an apparatus, 1 we used a Microsoft HoloLens as mixed reality glasses. To conduct the study, we first prepared an exhibition room in our lab. We used whiteboards to give a feeling of a room with white walls. We placed a pedestal, a bust and a painting in the room as seen in figure 2. A research assistant was coached to present the artifacts and costumed to play a guide wearing a black jacket and pants. We generated the realistic 3D representation from pictures of her by using FaceGen Pro [1] and DAZ3D [2]. Both the model and skeleton are based on the Genesis 8 model in DAZ3D. The animated model of a robot [3] was used for the less human-like representation. For conditions with a virtual guide, we recorded the research assistant's motion for each presentation using OptiTrack's full-body tracking system. In the real world condition, our research assistant played the guide herself.

During the study, four presentations were shown to each participant. We counterbalanced the order of *Guides* and presentations using a Latin square design. After introducing the purpose of the study, participants signed a consent form and answered questions about demographic data and experience with MR. We then introduced the Microsoft HoloLens, helped participants to wear it and told them to stand in front of the exhibition (see Figure 2). At the beginning of the study, each participant was informed about the comprehension tests, asked to pay attention to the guide's speech and to be as accurate as possible when

[1] https://facegen.com
[2] https://www.daz3d.com
[3] https://assetstore.unity.com/packages/3d/characters/robots/space-robot-kyle-4696

	Md	M	SD
MR-Abstract	6	6.19	1.97
MR-Audio	6.5	6.69	1.7
MR-Realistic	7	6.13	2.06
Real	7	6.81	1.64

Table 1: Comprehension measures for all conditions.

answering the questions. During the presentations, participants observed the exhibition items, listened to the guide's speech and a piece of music by the corresponding composer while standing two meters away from the guide. After each presentation, participants answered ten comprehension questions and filled the co-presence questionnaire. During this time, the research assistant changed the bust and the painting of the composer to the next ones. Afterward, participants continued with the remaining conditions. Each presentation took on average four minutes containing 15 seconds of a piece of music by the corresponding composer.

Results

Each participant experienced four presentations, one with each condition. Table 1 summarizes the participants' comprehension. A Friedman Test revealed no significant effect on comprehension, $\chi^2(3)$=2.364, p=$.501$. A repeated measures ANOVA using Greenhouse-Geisser correction showed a statistically significant main effect of the *Guide* on co-presence ($F(2.493, 37.392) = 62.821, p < .001$). Post hoc tests using Bonferroni correction revealed statistically significant differences between all but not between the *MR-Abstract* and the *MR-Audio* conditions (see Table 2).

		M	SD	sig.
1	MR-Abstract	2.483	.843	3*, 4***
2	MR-Audio	1.875	.977	3**, 4***
3	MR-Realistic	3.213	.928	1*, 2**, 4***
4	Real	5.025	.991	1***, 2***, 3***

Table 2: Co-presence measures for all conditions. The mean difference is significant at the * p<.05, ** p<.005, *** p<.0005 levels.

Discussion & Limitations

In this paper, we investigated the effect of a virtual guide on the experience of a real-world exhibition. On average, *MR-Realistic* and *Real* conditions resulted in the highest comprehension. However, we found no statistically significant difference among the conditions. The results suggest that the appearance of the guide might have a negligible effect on learning outcome. It implies that an abstract and a realistic representation of a virtual guide might not distract from paying attention to the guide's explanations. Our results showed that the co-presence is higher using a realistic avatar compared to an abstract avatar or an audio-only presentation. Previous work showed that the visual presence of an avatar provides higher motivational and affective outcomes in learning activities than the audio-only case [3]. Therefore, we can conclude that a realistic representation of guides can be used in exhibitions to increase engagement with the content without an adverse effect on learning.

We recognize that our approach has limitations. We conducted the study in the lab without distractions from the environment. In a real exhibition, it is usually not quite and there are several people next to exhibition items. Future work should investigate the effects of such influences. Future work should also investigate the appearance and place-

ment of virtual guides when there are multiple other people around. Moreover, as mixed reality glasses, we used a HoloLens which has a limited field of view and resolution. Since in the study, the virtual guides had the same size as the real guide (the research assistant), it was only possible to see part of the virtual guide at the same time. Despite this limitation, participants could perceive the presence of realistic and abstract virtual guides. However, future research with mixed reality glasses with a wider field of view is needed to determine the effect of this limitation.

Conclusion

We investigated the presence and appearance of a guide in a mixed reality exhibition. We studied how the representation of a guide (human guide, realistic virtual guide, abstract virtual guide, and audio guide) affect comprehension of the guide's speech and the perceived co-presence. We found that realistic representation of a virtual guide results in higher co-presence and does not distract from the learning activity. The findings can be used as design recommendations for developing mixed reality guides for exhibitions.

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