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DOI
10.1007/978-3-031-47655-6_7

Publication date
2023

Document Version
Final published version

Published in
Interactive Storytelling - 16th International Conference on Interactive Digital Storytelling, ICIDS 2023, Proceedings

Citation (APA)
Gong, Z., Gonçalves, M., Nanjappan, V., & Georgiev, G. V. (2023). VR Storytelling to Prime Uncertainty Avoidance. In L. Holloway-Attaway, & J. T. Murray (Eds.), *Interactive Storytelling - 16th International Conference on Interactive Digital Storytelling, ICIDS 2023, Proceedings* (pp. 103-116). (Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics); Vol. 14383 LNCS). Springer. https://doi.org/10.1007/978-3-031-47655-6_7

VR Storytelling to Prime Uncertainty Avoidance

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Abstract In recent years, there has been a growing interest among researchers in the field of virtual reality (VR) storytelling. There is a lack of studies on using VR storytelling to prime culture-related content. The cultural aspects, particularly the tendency to avoid uncertainty, have yet to be thoroughly examined within VR. Therefore, we developed VR storytelling intending to prime individuals' uncertainty avoidance values. An experiment was conducted to assess the e cacy of VR storytelling in priming individuals' uncertainty avoidance values. The participants' encounter with VR storytelling was assessed through various parameters, including but not limited to their experience of presence and engagement in the virtual environment. The study provides evidence that VR storytelling has the capacity to influence individuals' cultural values, particularly their inclination to uncertainty avoidance. Furthermore, the feedback provided by the participants revealed that they had positive emotions, a feeling of being present, engagement, and immersion while engaging with such VR storytelling.

Keywords: VR storytelling · cultural value · uncertainty avoidance · priming

Introduction

Numerous scholarly investigations have examined the impact of storytelling on the formation of individuals' values (e.g., [14,25,29,37,39,41,44]). Narratives were employed to elicit cognitive and intentional responses in individuals, specifically in relation to their self-construal [14] and their intention to utilize safety belts [36]. Furthermore, it has been suggested by scholars that the incorporation of virtual reality (VR) technology into the realm of storytelling, commonly referred to as VR storytelling, has the potential to act as a mechanism for activating individuals' cultural values and o ering benefits such as heightened feelings of immersion and engagement, in contrast to traditional storytelling methods [16]. To date, there has been a lack of empirical research examining the impact

L. Holloway-Attaway and J. T. Murray Eds.): ICIDS 2023, LNCS 14383, pp. 103–116, 2023.
https://doi.org/10.1007/978-3-031-47655-6 7

of VR storytelling on priming the cultural values of individuals. Drawing inspiration from the aforementioned studies, we devised VR narratives and proceeded to conduct an empirical investigation to assess the efficacy of utilizing VR storytelling as a means of priming individuals' cultural values. Furthermore, an analysis was conducted on the a ective experiences of the participants during VR storytelling. Our objectives in implementing VR in the realm of storytelling are twofold. Firstly, we seek to comprehend the impact of VR storytelling on priming individuals' cultural values, specifically their inclination towards uncertainty avoidance (UA). Secondly, we aim to explore various outcomes that arise from VR storytelling, including participants' experience of immersive, engagement, presence and the positive emotions it evokes in participants.

2 Background and Related Work

2.1 Storytelling

The custom of telling stories has been passed down for millennia. Storytelling is how people tell stories for entertainment, knowledge sharing, or maintaining cultural heritage [28]. "Storytelling is a uniquely human experience that enables us to convey, through the language of words, aspects of ourselves and others, and the worlds, real or imagined, that we inhabit" [4, p.31]. We follow this definition of storytelling as the term of storytelling in our study.

The primary objective of storytelling is to elicit emotional and cognitive responses from the audience, as noted by Lugmayr et al. [28]. The utilization of storytelling is prevalent within the field of education, as it facilitates the dissemination of knowledge to students [8,42]. The utilization of storytelling within organizations is a common practice [9,12] with the purpose of transmitting organizational culture and fostering a strong sense of affiliation between employees and the organization [12]. Furthermore, it has potential applications in the realm of design education, serving as a catalyst to motivate novice designers to enhance the originality of their ideas in incubation [3]. The significance of storytelling in the advancement and dissemination of culture has been widely acknowledged [7]. This is exemplified in tribal societies where oral narratives serve as a means to safeguard crucial aspects of myths and legends for posterity. Tribal cultures employ the practice of repeatedly sharing purposeful stories over an extended period to e ectively transmit the essential components and significance of their values, beliefs, and governing structures. This process serves to enhance the cohesion of their communities [8,20].

2.2 Stories for Priming Cultural Values

The concept of priming is associated with the unconscious component of human memory, which involves the enhancement of cognitive processes [38] and influences social behaviours and intentions [11]. The phenomenon of priming refers to the increased accessibility of a specific category of information when individuals

are exposed to a particular stimulus, such as an event [25]. The length of the priming e ect may be influenced by many variables, including the characteristics of the priming itself, the strength of the priming stimulus, and individual differences in cognitive processes [32]. The temporal extent of short-term priming e ects may vary from milliseconds to several minutes, during which they possess the capacity to influence immediate perceptual or cognitive processes [32]. Numerous narratives were employed to prime cultural values and assessed the subsequent behaviours and intentions of participants [25,29,37,39,41]. The narrative of the warrior Sostoras has been extensively employed to e ectively prime cultural values, as evidenced by various iterations of the story that elicit either individualistic or collectivistic responses [14,37,43]. Hence, it has been demonstrated that narratives, when presented in written form, serve as a pragmatic method for activating cultural values.

2.3 VR Storytelling Priming Cultural Values

Virtual reality (VR) refers to a computer-generated simulation environment that enables individuals to experience a sense of presence, immersion, and engagement with a simulated world, facilitated by specialized electronic equipment such as a head-mounted display [15]. Several scholars have put forth the idea of utilizing VR as a means to prime cultural values through storytelling [16,17]. Presenting a story in a vivid and immersive way provides opportunities for priming individuals' subconscious and influencing their subsequent behaviours and responses [16,17,34]. In contrast to alternative narrative mediums such as written texts or videos, VR o ers a heightened level of immersion by constructing a virtual environment that engenders increased arousal and presence, thereby evoking a profound sense of presence or "being there," [6]. Furthermore, it has been suggested that the utilization of VR immersive environments may lead to heightened levels of engagement among participants [2], in contrast to conventional methods of storytelling. Furthermore, it is possible to create virtual environments that incorporate contextual cues with the intention of aligning them with the narrative or priming objectives [17]. This approach has the potential to elicit anticipated behaviours in individuals that align with the intended priming objectives [21].

2.4 Research Aim

Notwithstanding the potentially e ective approaches delineated in previous scholarly examinations regarding the utilization of VR storytelling to prime cultural values [16], the existing body of empirical research is insufficient to substantiate these assertions. Hence, the objective of our research is to develop a VR narrative and evaluate the efficacy of VR storytelling in priming the cultural values of individuals. Our research focus and previous investigations have led us to be particularly interested in the UA value. It has been observed that individuals' UA values have a significant influence on their experiences and outcomes in the field of creativity [19]. In a previous study conducted by authors,

it was observed that individuals with a low UA value exhibited a commensurately low level of workability in the ideas they generated. As a result, our study aimed to prime individuals' UA values by utilizing a VR narrative. Subsequently, we sought to evaluate any changes in their UA values following the VR storytelling experience, serving as the preliminary pilot investigation. The present pilot study will establish a foundation for our forthcoming research endeavours in the domains of design and creativity to address and mitigate the adverse cultural impact. Furthermore, our research endeavours to investigate individuals' subjective experience in VR storytelling, encompassing aspects such as engagement, immersion, and emotional responses.

3 Experiment

In order to evaluate the efficacy of VR storytelling in priming individuals' UA values, the initial step involved the development of a VR narrative. An experimental investigation was conducted to evaluate the efficacy of a particular intervention (VR storytelling) within a controlled laboratory setting equipped with tables, chairs, and displays.

3.1 Designing the VR Storytelling

UA is one of the cultural dimensions analyzed by Hofstede [24], which refers to the degree of anxiety and risk aversion that people feel during uncertain situations [24]. According to Hofstede's research, individuals with a higher level of UA tend to avoid situations characterized by uncertainty, perceiving uncertainty as a potential threat. Conversely, individuals with a lower level of UA tend to embrace risk-taking behaviours and believe life is inherently unpredictable [24]. The malleability of individuals' UA values and associated attitudes has been demonstrated in several studies [16,17,29,36]. As an illustration, researchers conducted a study to prime UA-related concepts (risk-taking), which demonstrated that individuals increased their risk-taking attitudes when they saw others win gambling games (a highly uncertain activity) because of their gambling knowledge and skills [29]. We designed the VR story for priming UA value by considering several elements: the story aimed to prime UA, the way of presenting the story, the VR avatars, the virtual environment, the interaction methods, and the position and movement of participants, inspired by Fisher et al., (2022) [13] and Wolfe et al., (2022) [40].

We adopted the Sostoras story from the previous studies [14,37] and modified the story to be used for priming UA value based on the description of UA and priming theory [23,38]. The story was further polished by an English editor. The background of the story describes a coming war: *"Sostoras a warrior in ancient Sumer was largely responsible for the success of Sargon I in conquering all of Mesopotamia. As a result he was rewarded with a small kingdom of his own to rule. About 10 years later Sargon I was conscripting warriors for a new war. Sostoras was obligated to send a detachment of soldiers to aid Sargon I"*

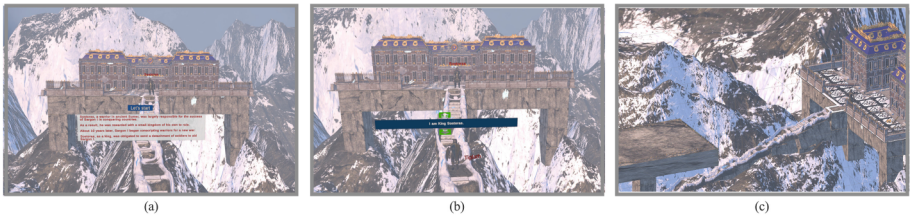

Fig 1 The screenshots of the VR story.

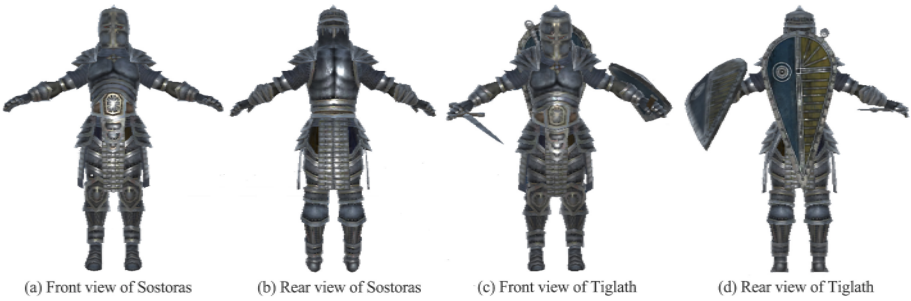

Fig 2 The views of avatars.

[37, p.652]. From this point, the story is divided into two branches. One is used for priming a higher value of UA, in which Sostoras decided to put Tiglath in command of the war, who is older and the best general, considering his vast war experience. As Tiglath has won many battles, choosing him increases the chances of winning the war. After cautious consideration, Sostoras decided to put Tiglath in command of the army. In the other branch, the story aims to prime a lower UA value: Sostoras decided to put Tiglath in command of the war. Tiglath is young and does not have much war experience, but he shows tactical skills. Although choosing him is risky, Sostoras wants to give him a chance to train to be an excellent general. Note that in both branches, the name of Tiglath is the same, but participants only see one version of the story. Both branches led to the same result: they won the war, their country received a large amount of compensation and land, and the country prospered. We built the VR story with the game engine Unity 3D, and the required items for the design could be purchased from the Unity Asset Store. We divided the story into two sections for **presenting the story**. The first section focuses on the background of the story, as illustrated in Fig. 1 (a); the next section is composed of the two-story branches, showing di erent content, but both are designed as an inner narration of King Sostoras (Fig. 1 (b)). After clicking start, one branch aims to prime higher UA values, while the other primes lower UA values. In addition, two distinct voice styles were developed for the story's narration. Specifically, the first involved a female voice which provided an account of the background, while the second comprised a male voice narrating the monarch's monologue.

For **designing the avatars**, the original story has three characters: Sostoras, Sargon I, and Tiglath; however, Sargon I is only mentioned twice in the story's background; thus, we only included two characters in the VR story, which were purchased from Unity Asset Store, and modified. In addition, to create the tense atmosphere of impending war, the characters were dressed in military uniforms, and the di erence between Sostoras and Tiglath is that Tiglath has a sword and shield on his back. Moreover, the avatars are covered by armour and helmet, which attempt to hide the avatar's race, and geographic characteristics to avoid potential biases [30], as shown in Fig. 2. To create a **virtual environment**, we have determined that the setting should be an ancient period with a tense atmosphere due to impending war, and the scene should feature an imperial palace. However, we have excluded several keywords, such as "Mesopotamia," as it may evoke di erent emotions in participants from diverse backgrounds. To enhance the experience, we have also selected intense background music that matches the story from the Unity Asset Store. For **interaction**, we designed a simple interaction in VR storytelling. Because the reading speed may vary among participants, we presented the story in sentences rather than paragraphs and designed two buttons to click forward and backward (Fig. 1 (b)). We attempted to design participants' initial **locations** and **movements** di erently in the VR storytelling and tested this with fellow researchers. This resulted in further iterations on the initial location of the VR storytelling. As such, participants start in a broad platform (Fig. 1 (c)) to observe the whole environment and characters. The platform allows participants to walk and run there naturally, depending on the scale of the lab room. However, they do not have an avatar to represent them, as self-identification plays a crucial role for the participants, and previous studies propose the use of a non-protagonist narrative [5]. Therefore, they are bystanders in the story.

3.2 Participants

A total of 24 participants were recruited through the utilization of posters. The individuals in question were enrolled as graduate students, primarily hailing from the Department of industrial design. The participants' mean age was 25.04, with a standard deviation of 3. In terms of gender distribution, 41.7% of the participants identified as male, while 58.3% identified as female. Before being assigned to the two experimental conditions, participants were instructed to fill out a questionnaire that gathered information about their demographics, hand preference, and uncertainty avoidance scales. Based on their UA value, they were divided into two conditions in a between-subjected study, as depicted in Fig. 3. Participants with a higher UA value were placed in the low priming UA condition (LPUA) in order to enhance their tolerance for ambiguity and promote risk-taking behaviour. This was exemplified by the selection of Tiglath, a young and inexperienced individual, as the chosen candidate by the king. In contrast, individuals exhibiting a lower level of UA were divided into the high priming UA condition (HPUA), where Tiglath is chosen based on his war experience and established competence, thereby reducing the level of risk, as shown in Fig. 3.

Each condition includes 12 participants, five male and seven female, and there is no significant di erence in age between the two conditions.

3.3 Procedure

The experiment was partitioned into five sequential stages, as depicted in Fig. 3. During the experimental procedure, participants were requested to complete the informed consent form, which was followed by an invitation to utilize a VR headset, specifically the Oculus Quest 2, to engage with VR storytelling on two occasions, with a total duration of fewer than 10 min. The initial session served as a preparatory exercise, during which individuals were encouraged to engage in walking, observing, and exploring the virtual environment, with the purpose of familiarizing themselves with the capabilities of VR. During the subsequent iteration, participants were instructed to observe and attentively engage with the VR story presented in Sect. 3.1. Subsequently, a task of ideation was administered, wherein participants were instructed to generate ideas. Given that the focus of this paper does not revolve around the ideation task, we refrain from engaging in a discussion or providing an explanation of it. The last two steps included questionnaires (to measure the uncertainty avoidance again) and a short interview. One aspect of the interview process was designed to ensure that the participants remained unaware of any priming influences, as noted by Molden (2014) [31].

Fig 3 The experiment's procedure.

3.4 Measurements

The **uncertainty avoidance scale** was adopted in the study to measure individuals' UA values on a Likert-type scale. This has been previously developed by Jung & Kellaris (2004) [27] based on the description of cultural dimension [23]. The original scale consisted of eight items; however, one item *"I would prefer to stay with one employer as long as possible"* was excluded from the analysis. This decision was made due to the fact that the participants in our study consisted of students, the majority of whom lacked prior work experience. The uncertainty

avoidance scale has been utilized in prior research to gather data on individuals' UA values and has demonstrated strong reliability and validity [1,27].

The **user experience in immersive virtual environments** was developed by the utilization of existing questionnaires [35]. The original questionnaire consisted of 82 items that were designed to assess various aspects of users' experiences, including presence and immersion within immersive virtual environments. Nevertheless, the initial survey is of considerable length, potentially leading respondents to develop a reduced sensitivity or responsiveness when providing answers [33]. Furthermore, a considerable number of items included in the initial questionnaire were deemed inappropriate for the purposes of our research. For example, participants observed the story from a platform as a whole rather than conducting a detailed examination of objects. Hence, the incorporation of the statement *"I had the capacity to closely analyze objects "* was considered irrelevant. Consequently, a limited number of questions was chosen to examine the participants' experiences with VR storytelling, focusing on the dimensions of presence, immersion, engagement, and emotion [35].

4 Results

4.1 The E ectiveness of Priming UA Values by VR Storytelling

The UA values of participants were collected on two occasions, both before and after the VR storytelling experience, in order to assess the efficacy of using VR storytelling as a means of priming individuals' UA values. A paired sample t-test was employed to assess whether there is a statistically significant di erence in the mean between paired observations. These observations consist of either the same individuals tested at two di erent time points or individuals tested under two distinct conditions on the same dependent variable. It is appropriate for our research to conduct repeated testing on the same individuals.

In the **HPUA condition** (participants with a low UA value in the condition to prime their UA values high), one outlier was detected; therefore, we replaced the outlier's value with one that is less extreme (median value) [26]. The di erence scores for the first UA value and second UA value were normally distributed, as assessed by Shapiro-Wilk's test ($p = .506$). Data are mean ± standard deviation unless otherwise stated. Participants' UA values increased after VR storytelling in the HPUA condition (17.5 ± 3.06) as opposed to before (16.08 ± 3.60), a statistically significant increase of 1.41 (95% CI, 2.81 to 0.02), $t(12) = 2.24$, $p = .047$, as shown in Table 1.

In the **LPUA condition** (participants with a high UA value in the condition to prime their UA values low) there were no outliers in the data. The di erence scores for the first UA value and second UA value were normally distributed, as assessed by Shapiro-Wilk's test ($p = .443$). Participants' UA values decreased after VR storytelling in the LPUA condition (21.25 ± 2.77) as opposed to before (24.75 ± 2.83), a statistically significant decrease of 3.5 (95% CI, 4.57 to 2.43), $t(12) = 7.22$, p .0005 (Table 1).

Table 1 Paired samples test.

Conditions	Paired Samples	Mean	Std. Deviation	t	Sig. 2-tailed)
HPUA	After VR storytelling	17.50	3.06	-	-
	Before VR storytelling	16.08	3.60	-	-
	After - Before VR storytelling	1.42	2.19	2.24	.047
LPUA	After VR storytelling	21.25	2.77	-	-
	Before VR storytelling	24.75	2.83	-	-
	After - Before VR storytelling	-3.50	1.68	− 7.22	0.000

4.2 User Experience in Immersive Virtual Environments

This study examined four distinct factors pertaining to users' experience in VR storytelling. Specifically, we employed a 5-point Likert scale to measure participants' perceptions of presence, engagement, immersion, and emotion. Concerning the presence factor, approximately 80% of the participants demonstrated a positive attitude towards the feelings of being in the virtual environment. Regarding engagement, 60% of participants reported feeling involved in the virtual environment experience. Additionally, roughly half of the participants reported feeling stimulated by the virtual environment and becoming less aware of their surroundings because they were immersed in the virtual world. Regarding the emotional factor, 75% of the participants indicated they enjoyed and relaxed while engaging with the virtual experience.

5 Discussion

The results showed that the di erence scores abstracted in the two times questionnaires (before and after VR storytelling) in two conditions di ered, 3.5 in LPUA and 1.42 in HPUA, which means the priming lower UA values is more e ective than priming higher UA values. These results suggest that participants were more easily to be primed with lower UA values than higher ones. The interviews provided further insights into this: participants, especially from the design area, tend to be risk-taking and more adventurous (characteristics that people with low UA value usually exhibit) in study and design. For example, when we explained our research aim and told one participant that he has a higher UA value (i.e., demonstrates risk-averse characteristics), he looked unhappy, directly expressing his disagreement with the UA questionnaire results. Another example is a female participant who indirectly referenced her preference for remaining within her comfort zone and aversion to taking risks. However, when engaged in the process of studying and designing, she actively challenges and takes risks herself to produce unconventional and daring ideas. Conversely, when we explained our research aim and told participants with a lower score of UA their questionnaire results, they expressed pride and pleasure in being risk-takers. In another example, a participant reported how his ideas surprised team members and were curious about how he came up with a solution they had never considered. Nevertheless, he believed it was everyday thinking and uncertainty that triggered creativity.

Although a few individuals expressed dissenting opinions, the majority of participants reported positive experiences with VR storytelling, including the sense of being present in the virtual environment, high levels of engagement, complete immersion in the story, and the elicitation of positive emotions. We endeavoured to extract and identify the underlying reasons for these disagreements. This may be because the scale of the lab room limited their movement in a virtual environment. When they were near physical objects in the lab room, purple border lines in the virtual environment reminded them and potentially disturbed the immersive experience of VR storytelling. Notwithstanding this fact, VR storytelling persists in providing a sense of presence, immersion, engagement, and pleasure, thereby a ording a prospect to foster cultural values among individuals through VR storytelling, in contrast to other customary forms of storytelling, such as oral or textual [6,10].

6 Limitations

Similar to other studies, we have several limitations. The research encompasses a cohort of 24 individuals, and the limited sample size may impact the extent to which the findings can be applied to a broader population. In addition, it is advisable to incorporate a control group into our research design in order to assess the disparity between the two priming conditions and a neutral condition. Concurrently, doing a comparative experimental study between VR storytelling and other storytelling mediums has considerable potential to substantiate the advantages of VR storytelling by acquiring more robust empirical data. Moreover, the duration of the priming e ect remains uncertain since our testing only included a limited timeframe. Furthermore, it is important to highlight that the VR story was predominantly developed with the purpose of priming UA values, while neglecting to adequately address alternative viewpoints, such as the aesthetics and visual representation of avatars and the virtual environment.

7 Conclusion and Future Work

Researchers have proposed methods to prime individuals' cultural values through VR storytelling, drawing on priming theory and Hofstede's cultural dimensions [17]. Consequently, we developed a VR story to prime individuals' cultural values, particularly in uncertainty avoidance (UA). Subsequently, we conducted an assessment to confirm that individuals' UA values could be successfully primed to be either higher or lower than their initial UA values through the use of VR storytelling. To the best of our knowledge, our study is the first empirical study to show that VR storytelling could be used to prime individuals' cultural values and demonstrated that such primed individuals' UA values were significantly di erent. Furthermore, the participants expressed a sense of enjoyment towards VR storytelling and exhibited positive attitudes towards the presence, engagement, and immersion experienced during the VR narrative.

Our study contributes to various disciplines in education and industries, such as design practice. Creativity is an essential element for design students and employees that could positively a ect various academic and social outcomes, such as scholastic performance and breakthrough products [18,19,22]. Priming individuals' UA values to become lower may inspire designers to take risks in the design process, potentially increasing the chances of novel outcomes. Oppositely, priming individuals' UA values to increase may lead designers to become cautious and favour useful solutions rather than novel solutions in ideation. In industry, collaborative teamwork is a ubiquitous modality of work that involves a group of individuals pooling expertise, resources, and e ort toward achieving a common objective. Within teamwork, team members are tasked with jointly planning and executing a product development process, which may encompass activities ranging from the generation of the initial idea to the screening of prototypes, and ultimately culminating in the delivery of a final product. During ideation, team members could be primed with a lower UA value to generate wild and novel ideas. In the ideas selection phases, individuals could be more thoughtful in selecting practical and workable ideas by priming them with a higher UA value.

The present study represents a novel avenue of inquiry in VR research, wherein built VR stories based on the priming theory, is employed to influence individuals' cultural values. In accordance with the priming theory, their subsequent behaviours and intentions could be influenced [38]. Therefore, our future objective is to investigate the impact of VR stories on the outputs and creativity of individuals in design processes. Specifically, we plan to examine the e ects of VR storytelling on individuals who have been primed to balance their UA values. It aims to determine whether such priming can reduce the negative influence of UA values or enhance the positive influence of UA values in design and creative performances. Our study might inspire researchers to explore priming individuals' cultural values, which might a ect their subsequent behaviours. Moreover, it is promising to compare VR storytelling with other forms of storytelling, such as oral and video storytelling, which will help researchers understand the benefits of VR in storytelling than other forms of storytelling.

Acknowledgements This work was supported by the Research Council of Finland (former Academy of Finland) 6G Flagship Programme [Grant Number: 346208]; China Scholarship Council: [Grant Number 202107960006]; Opetushallitus (Finnish National Agency for Education): [Grant Number TM-20-11342]; and European Union's Horizon 2020 research and innovation programme [Grant Number H2020-856998].

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