Article

An Evaluation of the Effects of a Virtual Museum on Users’ Attitudes towards Cultural Heritage

Felipe Besoain 1,2,†, Jorge González-Ortega 2,† and Ismael Gallardo 2,*,†

1 Faculty of Engineering, Campus Talca, Universidad de Talca, Talca 3460000, Chile; fbesoain@utalca.cl
2 Faculty of Psychology, Campus Talca, Universidad de Talca, Talca 3460000, Chile; jorge.gonzalez@utalca.cl
* Correspondence: igallardo@utalca.cl; Tel.: +56-712200200
† These authors contributed equally to this work.

Abstract: (1) Background: Several opportunities have appeared for the dissemination of culture and heritage thanks in part to the widespread use of information and communications technologies. Virtual museums have appeared as innovative technological products but often lack an evaluation of the impact that they have and their success in achieving their purpose. In this sense, this work seeks to evaluate the impact of a virtual museum on users’ attitudes toward cultural heritage. (2) Methods: We used a factorial design of 2 (direction of thoughts: positive vs. negative) × 2 (presence level: high vs. low) × 2 (virtual museum vs. interactive website). (3) Results: Attitudes toward heritage can change as a function of a multimedia experience, thought favorability, and presence. In a virtual museum, when general attitudes are evaluated, a sense of high psychological presence reduces the effect that thoughts (especially when negative) have on attitudes. However, in the case of visiting an interactive website, the effect of the direction of thoughts on attitudes occurred regardless of conditions of high or low presence. Similar tendencies are observed for specific attitudinal objects. (4) Conclusion: A virtual museum can have different effects depending on the interaction of important variables from the virtual reality literature and not only the classic main effects. Recommendations for interventions and future practical and theoretical work are presented.

Keywords: virtual museum; cultural heritage; virtual environments; interaction techniques; software development; attitude change; ELM

1. Introduction

One of the main functions of museums is to protect and strengthen elements that make up the identity of a community and the society that surrounds it. Traditionally, these elements are generally understood as heritage, which refers to tangible and intangible assets that are inherited from the ancestors of each person, being passed from generation to generation [1,2]. Nevertheless, confinement and lockdowns due to COVID-19 have produced several limitations on activities with physical presence in museums, reducing their impact on social identity. However, it is also an opportunity to create other ways to connect social heritage with a population [3] using information and communication technologies (ICTs).

ICT allows for access to information from different types of devices, such as smartphones, tablets, and wearable technology. The increasing interest in ICT is observed also in future investments and use. The market forecast for technologies such as augmented reality (AR), virtual reality (VR), and mixed reality (MR) is expected to reach 30.7 billion USD in 2021, increasing to close to 300 billion USD by 2024 [4], positioning these technologies as interesting targets to explore. There are several applications of these technologies from AR systems [5]. There are also applications from MR systems that integrate virtual with collaborative interaction methods to facilitate enhanced cultural learning in virtual heritage [6]. Finally, VR systems can be used for the presentation of virtual museums [7] and interactive software [8] with experiences related to cultural heritage.
Through different techniques such as photogrammetry [9] and the use of 3D scanners, historical pieces can be preserved in a digital 3D format, retaining their characteristics and textures [10]. After this process, many museums, such as the National Museum of Natural History of Chile [11], have published their pieces on websites such as Sketchfab [12], among others. For a review of a full guide of virtual heritage, see [13].

In this context, several opportunities have appeared for the dissemination of culture and heritage among websites, interactive experiences such as video games, virtual [7,14] and augmented reality [15], and serious games [8], to name a few. Traditionally, the way to appreciate this tangible heritage was to visit the museums and other cultural institutions in person. The use of virtual technologies and digital heritage is also relevant to the idea of a virtual museum, even more considering that the Internet offers new ways to spread and distribute information [16].

With these factors in mind (namely the utilization of technologies and advances in digitization processes), we developed a virtual museum [7] that includes several pieces from a local network of museums through a 3D digitization process. This virtual museum has a VR version for Oculus Go [17] and Quest [18] devices, and we also made this experience available in a desktop version due to the pervasiveness of computers. The purpose is to use technology to disseminate and increase people’s positive evaluations (or positive attitudes) toward cultural heritage and toward visiting physical museums.

However, what products such as a virtual museum often lack is an evaluation of the impact that they have and their success in achieving their purpose. In this sense, this work also seeks to evaluate the impact of a virtual museum on users’ attitudes toward cultural heritage and visiting physical museums using three important variables as factors. First, an important amount of studies on attitudes and virtual reality propose that positive attitudes depend on an increase in presence, that is, an increase in people’s sense of “being there” [19,20]. Second, contemporary theories in attitude change have shown that, in a communicative context, people not only receive information about an object (e.g., museums) but also generate different “cognitive responses” or “thoughts” as a result, which might be positive (e.g., “wow... it’s so real”) or negative (e.g., “not even close to reality”) toward the object [21]. For instance, when people are motivated to think, their thoughts can lead to positive or negative attitudes [22]. Finally, we used a control condition to compare the effects by having virtual 3D objects in an interactive website, as museums usually have.

For instance, the aim of the present work is to evaluate a virtual museum and its effects on general attitudes toward heritage by comparing them to the effects of observing the same elements in a more static webpage and using presence and thought generation measurements as factors. This paper is structured as follows: first, we describe the background of this work and the main features of both the virtual museum and the interactive website and, then, the relationship between thoughts and attitudes; second, we present the methodology of the experiment; third, we present the results; and finally, we describe our conclusions and future work.

2. Background

Attitudes have been studied in different contexts as they are a keystone for social psychology because they are relevant to aspects of daily life such as information seeking, approaching or avoidance behavior, and expression of people’s identities, among others [23,24]. Attitudes refer to general evaluations that people have regarding different objects, behaviors, persons (including oneself), things in general, etc., technically defined as “attitudinal objects” [25–27]. These evaluations have a valence, for example, (1) positive–negative, (2) good–bad, or (3) favorable–unfavorable.

The following are known from contemporary theories of attitude change [21,28]:

- A change in attitudes depends on the person that receives the information.
- In particular, how he/she cognitively responds towards it in positive–negative, good–bad, or favorable–unfavorable terms.
• When people take time to think, the direction of what is thought leads to consistent attitudes.
• When attitudes are formed from mechanisms of much thought, they are related to behavior.

In this scenario, the attitude change depends on the person that receives certain information, independent of the intentions of the message or the source.

In particular, how people generate cognitive responses (a cognitive response could be a response, thought, or idea towards information.) to the information received is critical for the following evaluation [29]. One dimension of thoughts is the direction of those responses. People can generate positive-favorable thoughts (for example, museums represent our past and give us a new opportunity to learn from it) or negative-unfavorable thoughts (museums are a waste of time) as a response to certain information.

Previous research showed consistently that thoughts with a positive valence lead to favorable attitudes and that the opposite occurs for negative valence thoughts, especially when people have the opportunity and motivation to engage in systematic thinking [21,28]. In order to study thought favorability, Killeya and Johnson [22] proposed and demonstrated that thinking about an object in a specific direction (positive or negative) leads to an attitude change in line with those thoughts.

Thus, when people are asked for their attitudes about a specific object, and in this case, cultural heritage, the direction of their thoughts can affect attitude valence [30], leading to positive attitudes when positive thoughts are present or negative attitudes when negative thoughts are present.

2.1. The Relationship between Digital Products and Attitudes

Regarding digital products, an increase in attitude favorability has been related to an increase in presence, which is the sensation of being truly present in the virtual reality environment [31]. Presence can be related to the experience of the physical world, occurring when the person has the subjective perception of being in a certain environment, even when they are not physically there, increasing the probability of experiencing the sensation of being truly present in the virtual reality environment. Thus, an increase in presence can lead to a perception of a non-mediated interaction, leading users to forget that they are using a digital device [32–34]. For example, Tussyadiah and colleagues [31,35] asked participants from Hong Kong and the UK to engage in a virtual walkthrough of Tokyo (Japan), Porto (Portugal), or the UK (a national park) using virtual goggles attached to their smartphones. After ten minutes, they expressed their sense of presence, attitudes, and intention to visit the places using a questionnaire. General results showed a positive and statistically significant association between presence and attitudes, and a positive relationship between attitudes and their intention to visit the places.

Nevertheless, presence is not the only variable that might be relevant for digital products. In a virtual experience, an individual might analyze the environment in an active way, leading to “cognitive responses” or thoughts about the object that might be relatively favorable (positive) or unfavorable (negative) toward the object that is assessed. It is expected, for instance, that either in a more or less immersive multimedia experience, as thought favorability increases, attitude favorability increases as well.

Thus, attitudes can change in virtual reality as a function of the type of multimedia experience, presence, and thought favorability. In summary, this study presents a virtual museum that allows participants to visit a simulated place in which they can interact with different objects. To evaluate the impact on attitudes toward heritage conservation, we compare the virtual museum with an interactive website, a traditional strategy of heritage institutions to show their items. In both cases, thought favorability and presence are measured and included as factors to evaluate the main and combined effect toward attitudes about heritage conservation. In the following subsection, we present the virtual museum and the interactive website with their functionalities to present our study with an evaluation of both products regarding users’ attitudes.
2.2. Virtual Museum

The virtual museum was originally developed for VR, with the aim of promoting and referencing regional museums where the pieces are located and encouraging users to visit them. In the present work, we took all of the narrative and objectives of the VR version and created a PC version, considering new features and functionalities that can be implemented on a computer and not in VR. For example, the PC version uses the mouse and keyboard of the computer as controllers to interact and move around the place, instead of an head-mounted display (HMD) and controller.

As part of the narrative, Maulina, a typical doll from Chile made of "crin" (horsehair weaving), acts as a guide, presenting the environment and the main functionalities, and takes the user through the available collections (see Figure 1).

![Figure 1](image-url)  
Figure 1. This figure presents different screenshots of the PC version of the virtual museum. From left to right: (a) Maulina welcoming the user in the central patio of the museum. (b) Main access to one of the available collections.

The virtual museum opens into a tutorial room, where users can learn how to move, select, and interact with the different objects of the environment. Additionally, Maulina gives them context and stories to enhance the users’ experiences.

When users finish the tutorial in the main room, Maulina prompts them to leave the room and to visit other areas in the museum. Each room represents a collection. Users can walk freely around the scene in all of the enabled spaces. In all of them, they can interact with objects such as particles, totems, and pieces, among others.

When users enter a collection room, Maulina summarizes the main characteristics of the presented objects and prompts them to move closer to each one. In this context, when the user moves closer to a piece, a special display is shown, in which they can access general and cultural information about the piece, such as the museum in which it is located. They can also examine the object itself, as can be seen in Figure 2, as well as spin and move the piece to appreciate its different angles.

Therefore, the virtual museum is a contextualized space that collects different pieces with cultural value from the local network of museums. Users can access collections, pieces, and information at their own pace and according to their interests. This virtual museum can be downloaded from Microsoft Store [36] (currently in Spanish-speaking countries).
Figure 2. This figure shows the graphical user interface in the virtual museum that is presented when users move close to any object in the available collections. In this interface, users can access information related to the piece, rotate it, and listen to Maulina summarize information about the item.

2.3. Interactive Website

This website was developed as an interactive repository of 3D pieces. This system is used as a control in our experiment, since these repositories are already used by some museums and they are a quick and easy way to present and show digitized pieces.

The repository allows us to upload the 3D models and to view them in 3D along with their information; for each piece, the system allows for spinning, zooming in/out, and visualizing high-resolution images; see Figure 3.

Figure 3. This figure shows the graphical user interface of the interactive website where users can access information related to the piece and rotate it.

For the experiment, we also included the same character Maulina, whose dialogue appears in a pop up the first time that users open the interactive website. In this way,
although the virtual museum and the interactive system are two different systems, their main contents and functionalities related to appreciating the 3D pieces are the same.

3. Materials and Methods

3.1. Participants

Ninety-eight Chilean subjects (48% female; average age 25.3; SD = 6.18) were invited to participate in the study through social media.

3.2. Procedure and Design

Through different social media channels, we invited the public to participate in research about new technologies for the study of cultural heritage. Participants were asked to visit a link describing the study. Half of the subjects received a download link for the virtual museum (simulator condition). The other half of the subjects received a link to the interactive website (control condition).

They were asked to look at the multimedia experience for a maximum of 10 min. Once finished, all participants had to visit a link containing a questionnaire to answer. On the questionnaire, the first task was to write down what they thought about the multimedia experience, applying the thought-listing technique [37,38]. Then, as a means of evaluating their attitude towards the multimedia experience, participants filled in semantic differential scales on virtual, in-person, and heritage-related aspects of the experience.

Subjects were randomly assigned to the experimental conditions (simulator/control). The measured factors were direction of thoughts and presence level reported by the multimedia experience, constituting a factorial design of 2 (direction of thoughts: positive vs. negative) × 2 (presence level: high vs. low) × 2 (virtual museum vs. interactive website).

3.3. Instruments

3.3.1. Independent Variables and Measurements

- Type of multimedia experience: As a means of controlling the type of multimedia experience that participants took part in, half of them were provided with a Windows Store download link for a 3D simulator containing a variety of virtual copies of real life cultural heritage objects from the Maule region [7]. The other half of the participants received a link to an interactive website hosted on the University’s website. This web page contained the same objects as the simulator but, in this case, presented through photographs.

- Thought favorability: Participants received a web questionnaire with ten open-ended question blocks for them to list their thoughts about the multimedia experience. They were asked to write one thought for each block (examples on the use of the thought-listing technique can be found on [39–42] Two independent judges who did not know about the conditions and experimental hypotheses subsequently codified these thoughts as positive, negative, or neutral toward the experience and resolved their disagreements through discussion. Some examples of positive and negative thoughts are, respectively: “I think it’s innovative and fun” and “The place causes me anxiety”. Using only the thoughts that related to the experience, an index of favorability of thoughts was created, subtracting the number of negative thoughts from the number of positive ones and dividing by the sum of both quantities.

- Presence index: We used the SUS scale of presence [33,43,44]. This instrument was answered in a seven-point Likert format (e.g., “Please rate your sense of being present in the multimedia experience, on a scale of 1 to 7, where 1 represents your normal experience of being in a place”; “To what extent were the times when the multimedia experience was the reality for you?”). A reliability analysis including the six items was performed, showing an appropriate but low reliability (a = 0.67). This improved when discarding item 6 (“During the experience, did you often think that you actually were in the multimedia experience?”). Due to this change, a sole index was created using only the first five items (a = 0.76).
3.3.2. Dependent Variables

- **Attitudes**: Participants answered a series of semantic differential items (e.g., “I think the multimedia experience is pleasant/unpleasant”) to assess their attitudes toward the multimedia experience. Four indexes of attitudes toward different elements measured by the questionnaire were generated. These were index of attitudes toward the multimedia experience, index of attitudes toward cultural heritage, index of attitudes toward visiting a virtual museum, and index of attitudes toward visiting a museum in person. Due to the high internal consistency within and between the different items (α = 0.84 for the index of attitudes toward cultural heritage being the lowest value), we decided to group items by indexes of attitudes. Each index was composed by the average of six semantic differential items (“pleasant–unpleasant”, “good–bad”, “necessary–unnecessary”, “negative–positive”, “I like it–I do not like it”, and “favorable–unfavorable”), rated on a scale of 1 to 7. Items were inverted to make it so that more positive values indicated more favorable attitudes. This procedure has been adapted from previous research [45]. Finally, due to the high consistency of the four indexes of attitudes toward the multimedia experience, we derived them from them an overall index of attitudes toward the heritage (α = 0.79).

3.4. Data Analysis

A moderation analysis was performed to estimate principal and interaction effects between independent variables on the index of attitudes. For this analysis, we performed several regression analyses using the PROCESS v3.5 macro for SPSS v25 [46], which evaluates predictions for each variable separately (main effects) and combined (interaction) on attitudes toward the multimedia experience. Statistical significance was assessed using the bootstrap method, extracting five thousand samples from the data at random and with replacement. Estimates of the effects on attitudes were calculated for each sample, building a confidence interval (CI). If the value “zero” is found outside of the CI, it is indicative of the effect of each factor or interaction on attitudes.

4. Results

4.1. Preliminary Analysis

To assess the effect of the different conditions of the independent variable on psychological presence, we compared the mean values of presence between the treatment and control groups. This was not statistically significant ($t(98) = −1.65, p = 0.10$). In the same way, we also assessed the effect of experimental conditions on the direction of the thoughts reported by participants. No statistical differences were found ($t(98) = 1.28, p = 0.89$).

4.2. Attitudes

4.2.1. Overall Index of Attitudes

We analyzed the moderating role of psychological presence, direction of thoughts and type of multimedia experience on the general attitudes toward the heritage (overall index of attitudes). The overall index of attitudes was subjected to a moderation analysis, where no main effects on said index were found for presence ($B = −0.1376, t(97) = 1.32, p = 0.18, CI [−0.6, 0.34]$), direction of thoughts ($0.6107, t(97) = 1.57, p = 0.11, CI [−0.15, 1.3]$) or the device used ($B = −0.3997, t(97) = −0.79, p = 0.42, CI [−1.39, 0.59]$).

Likewise, interactions between presence and direction of thoughts ($B = −0.0378, t(97) = −0.32, p = 0.74, CI [−0.27, 0.19]$) as well as interactions between presence and the device used ($B = 0.1827, t(97) = 1.15, p = 0.24, CI [−0.13, 0.49]$) were non-significant. Interaction between direction of thoughts and multimedia experience was found significant ($B = 1.2872, t(97) = 2.12, p = 0.036, CI [0.8, 2.48]$), showing that the direction of thoughts had a greater effect over the attitudes of participants in the virtual museum, where positive or negative thoughts were better predictors of positive or negative attitudes toward the multimedia experience than in the interactive website condition.
Finally, presence level, direction of thoughts, and the direction used had marginally significant triple interaction effects on the overall index of attitudes toward the museum experience ($B = -0.3450$, $t(97) = -1.92, p = 0.057$, 95 CI: $[-0.7010, 0.0110]$). This interaction revealed that predictive power of direction of thoughts and type of multimedia experience is more evident in low psychological presence conditions ($B = -0.3828$, $F(1,90) = 8.00, p = 0.005$). This means that, when people take part in a simulated experience about cultural heritage, high presence reduces the effect that thoughts (especially negatives) have on attitudes. In the case of visiting a interactive website, the effect of the direction of thoughts on attitudes occurred regardless of high or low psychological presence conditions (see Figure 4).

![Figure 4](image)

**Figure 4.** General attitudes according to reported levels of psychological presence and direction of thoughts.

### 4.2.2. Attitudes towards the Multimedia Experience

In the case of the index of attitudes towards the multimedia experience, a main effect for psychological presence ($B = 0.3837$, $t(97) = 3.11, p = 0.002$, CI $[0.13, 0.62]$) and direction of thoughts ($B = 1.3645$, $t(97) = 2.96, p = 0.003$, CI $[0.45, 2.27]$) on attitudes were found. This means that greater levels of presence predicted a more positive attitude toward the multimedia experience, and more positive thoughts about the experience predicted a more positive attitudes toward the multimedia experience.

No main effect for type of virtual experience was found ($B = -0.0794$, $t(97) = -0.13, p = 0.89$, CI $[-1.26, 1.10]$). No interaction effects were found between presence and direction of thoughts ($B = -0.2046$, $t(97) = -1.46, p = 0.14$, CI $[-0.48, 0.07]$), presence and device used ($B = 0.1372$, $t(97) = 0.73, p = 0.46$, CI $[-0.23, 0.50]$), and direction of thoughts and device used ($B = 1.1802$, $t(97) = 1.64, p = 0.10$, CI $[-0.24, 2.60]$).

No triple interaction between psychological presence, direction of thoughts and type of multimedia experience on the attitudes toward the multimedia experience was found ($B = -0.325$, $t(97) = -1.54, p = 0.12$, CI $[-0.75, 0.09]$; see Figure 5). However, as can be seen in Figure 5, there are similar tendencies than the overall index results.
4.2.3. Attitudes towards Heritage

For the index of attitudes towards heritage, psychological presence (B = 0.3837, t(97) = 3.11, p = 0.002, CI [0.13, 0.62]) and direction of thoughts (B = 1.3645, t(97) = 2.96, p = 0.003, CI [0.45, 2.27]) were found to have a main effect on attitudes. This means that greater levels of presence predicted a more positive attitude towards heritage, and more positive thoughts about the experience predicted a more positive attitudes towards heritage.

No main effect for type of virtual experience was found (B = −0.0794, t(97) = −0.13, p = 0.89, CI [−1.26, 1.10]). Marginally significant effect of interaction was found between the psychological presence and direction of thoughts on the attitudes toward heritage (B = −0.2253, t(97) = −1.85, p = 0.066, CI [−0.46, 0.01]). This means that, in conditions of low presence, positive thoughts predict positive attitudes towards heritage, just as negative thoughts predict negative attitudes. However, in high presence conditions, this effect disappears; see Figure 6. No other interaction effects were found.

4.2.4. Attitudes towards Face-to-Face Visits

In the case of the attitudes towards face-to-face visits, no main effects was found. The interaction between direction of thoughts and multimedia experience was found significant (B = 1.2872, t(97) = 2.12, p = 0.036, CI [0.8, 2.48]), showing that the prediction effect of direction of thoughts on attitudes towards heritage only operates under conditions of high presence. A marginally significant effect of interaction was found between the direction of thoughts and the device used (B = 1.5790, t(97) = 1.74, p = 0.083, CI [−0.21, 3.37]). This means that the predictive effect of thought direction on attitudes toward face-to-face visitation operated only in the website condition.

Finally, presence level, direction of thoughts, and the device used had a marginally significant triple interaction effect on the attitudes toward face-to-face visitation (B = −0.4617,
t(97) = −1.72, \( p = 0.087 \), 95 CI: \([-0.99, 0.06]\)). This means that the predictive effect of the direction of thoughts on attitudes towards face-to-face visits to the heritage site disappears in situations of high psychological presence in the case of the virtual museum. In the case of the interactive website, the predictive effect of thought direction on attitudes towards face-to-face visits to heritage sites is clearer under conditions of high presence (see Figure 7).

Figure 7. Attitudes towards face-to-face visits and the reported levels of psychological presence and direction of thoughts.

4.2.5. Attitudes towards a Virtual Visit

In the case of the attitudes towards a virtual visit, the device used (\( B = −1.6426, t(97) = −2.14, p = 0.034, \text{CI } [−3.16, −0.12] \)) was found to have a main effect on the attitudes. This means that the attitudes of those who used the virtual museum were more positive than those who used the website. An interaction effect was found between the level of presence and the device used (\( B = 0.5303, t(97) = 2.21, p = 0.029, \text{CI } [0.05, 1.00] \)). This means that attitudes towards the virtual visit were higher when experiencing higher levels of psychological presence only in the case of the virtual museum. On the other hand, an interaction effect was found between the direction of thought and the device used (\( B = 2.4531, t(97) = 2.66, p = 0.009, \text{CI } [0.62, 4.28] \)) on attitudes towards the virtual visit. This means that attitudes towards the virtual visit were higher when presenting positive thoughts but only in the case of the virtual museum.

Finally, presence level, direction of thoughts, and the device used had a significant triple interaction effect on the attitudes toward the virtual visit (\( B = −0.6464, t(97) = −2.37, p = 0.019, \text{CI } [−1.18, −0.10] \)). This means that the predictive effect of the direction of thoughts on attitudes towards the virtual visit (i.e., more favorable attitudes with positive thoughts) can be observed in conditions of low presence and only in the use of the virtual museum (see Figure 8).

Figure 8. Attitudes towards a virtual visit and the reported levels of psychological presence and direction of thoughts.
5. Discussion

In this study, we evaluated the impact of the PC version of the virtual museum on users’ attitudes towards cultural heritage and towards visiting physical museums, using contemporary theories on attitude change and presence as measuring factors.

As a control, we developed an interactive website where users can visualize historical pieces as 3D objects, including the same information and functionalities as the virtual museum. The development process was successful in porting the virtual reality experience to a PC version, thanks to the Unity 3D game engine and to scalable and modular programming.

The results showed that a virtual museum and an interactive website do not have main effects on attitudes toward heritage (except for a virtual visit). Specific results can be observed as a function of interactive effects of either thoughts, experience, or presence. As a consequence, we draw different conclusions depending on the type of object that we want to evaluate. If general attitudes are the focus, a virtual museum reduces the negative impact of negative thoughts, leading to positive attitudes, especially when high presence is perceived. However, if it is not possible to have a virtual museum, an interactive website can be useful regardless of presence if it is designed to generate mostly positive thinking at the beginning with a simple instruction as a pop-up page (e.g., Why do you think that museums exist?). If a specific attitude is the focus, other conclusions are possible. For example, attitudes toward heritage are affected by presence and thought direction with main and interactive effects, regardless of the multimedia experience. Therefore, we recommend both as generating positive thoughts and creating high presence environments.

Another conclusion can be derived from face-to-face or virtual visits. A virtual museum leads to positive attitudes regardless of thought direction, but an interactive website can have positive consequences as a function of high presence and positive thinking. However, for virtual visits, the opposite is observed. Interaction via thinking and high presence are useful in developing positive attitudes, but no interactive or main effects seem to be critical for the case of the interactive website. Therefore, according to the conducted experiments, which technological product to develop should be chosen depending on the attitude one wants to promote in potential users.

Limitations and Future Work

Some limitations of the present work are as follows:

• The time that participants dedicated to each condition of the test (virtual museum and interactive website): as the simulator and the website were hosted on different servers, we were not able to measure time of observation, which is associated with more capacity to analyze the information as people invest more time [21]. It might be the case that a certain multimedia experience is related to the investment of more time, affecting the results.

• Other demographic variables: we did not include other demographic variables besides gender and age because we do not have any hypothesis regarding alternative variables to understand potential differences between the types of systems and attitudes. Since participants were randomly assigned, the potential bias from those demographics is constant across conditions. Nevertheless, we analyzed if there were any differences in the percentage of men and women or age between conditions. A chi-square analysis showed no significant differences between gender ($X^2(2) = 4.18; p = 0.12$) and age ($t(96) = 0.95; p = 0.34$), suggesting that potential differences in sample distribution are not responsible for our results.

Some aspects of future work include the following:

• Controlling the time investment and including a new and more immersive multimedia experience: this could be applied using the VR version of the virtual museum with Oculus devices (i.e., HMD). More importantly, the results of this study allow for a discussion about the potential reasons that underlie the shown effects. For example, if
the multimedia experience does not lead to more presence, what is the role of those types of experiences? Some research showed that the effect of different devices or experiences on attitudes are based on immersion (an objective measure of a virtual device) rather than presence [32]. Then, how can presence be enhanced? Research on transportation [47] showed that a feeling of “being there” is enhanced when a story precedes the experience, inviting the user to imagine the place. In our case, both experiences have the same story, which might be the reason for the absence of differences.

- Exploring different objects and simulated situations to replicate the pattern of results of the present study: this includes several factors such as integrating presence and thought favorability, along with other variables such as changes in the level of detail (LoD) of the software. Traditionally, an increase in LoD tends to enhance attitudes by itself. However, based on our results, LoD might lead to positive or negative attitudes depending on the variable that it interacts with. Moreover, it might be the case that LoD has no influence at all when the story behind the software is interesting and engaging [47]. Thus, a software with a very low LoD might lead to positive attitudes if it is based on a good story (i.e., lead to favorable thoughts), in a similar vein that reading a good book (a very low LoD) leads to satisfaction when it is finished. This pattern of predictions is observed in Figure 4, right panel (pag. 8). However, depending on the attitudinal object, the previous pattern might change on interacting with presence and thought favorability (as in attitudes toward face-to-face visits). Finally, it could be interesting to analyze changes in other attitudinal objects related to heritage when individuals explore a simulated or a web-based museum. For example, attitudes toward local entrepreneurship, hand-crafting, or rural tourism could change if they are psychologically linked to the primary object, leading to an indirect change in attitudes (e.g., [48]).

- Continuing research on attitude change: Figure 4 shows that, regarding general attitudes, positive and negative thoughts lead to similar results on attitudes as presence increases but to main effects when there is low presence. Following the elaboration likelihood model of persuasion (ELM, [21]), it could be that high presence in a virtual experience, since it is a positive feeling, might reduce the motivation to think and the effect of thought direction. It also might be the case that presence affects the validity of thoughts [28], reducing their impact on attitudes, especially with the negative ones (“I thought that museums are bad, but after the experience, I seriously doubt that”). In any case, our results show that the analysis of the effect of a virtual museum on attitudes toward cultural heritage is not derived only by simple effects, but especially for interactions that can guide some theoretical explanations for the observed consequences. In the future, the study of cultural heritage can benefit from interventions observing thoughts and feelings of presence, providing new insights for understanding attitude change in the ICT context.

Author Contributions: Conceptualization, F.B., J.G.-O., and I.G.; investigation, F.B., J.G.-O., and I.G.; methodology, I.G.; writing—original draft, F.B. and J.G.-O.; writing—review and editing, F.B., J.G.-O., and I.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: This study was conducted according to the guidelines of the Declaration of Helsinki. Ethical review and approval were waived for this study, since the assessment of procedures lead to the conclusion that there was no difference with a normal procedure at the end of a traditional museum visit. For instance, no harm or damage to any person who evaluate either version of the museum was expected. Nevertheless, informed consent was obtained from all subjects involved in the study, including anonymity, confidentiality, and free choice for participation or drop-out on any part of the study without any need for further explanation.
Acknowledgments: Thanks to the project ANID FONDECYT Postdoctorado Folio N° 3210255.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations
The following abbreviations are used in this manuscript:

- VR: Virtual Reality
- HDM: Head-Mounted Display
- CI: Confidence Interval
- SD: Standard Deviation
- ICT: Information and Communication Technologies

References

1. Cuetos, M.P.G. El Patrimonio Cultural. Conceptos Básicos; Universidad de Zaragoza: Zaragoza, Spain 2012; Volume 207.
2. The Criteria for Selection-UNESCO. Available online: https://whc.unesco.org/en/criteria/ (accessed on 20 October 2021).
3. Almeida, F.; Duarte Santos, J.; Augusto Monteiro, J. The Challenges and Opportunities in the Digitalization of Companies in a Post-COVID-19 World. *IEEE Eng. Manag. Rev.* 2020, 48, 97–103. [CrossRef]
4. Augmented (AR), Virtual Reality (VR), and Mixed Reality (MR) Market Size Worldwide from 2021 to 2024. Available online: https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/ (accessed on 20 October 2021).
5. Russo, M. AR in the Architecture Domain: State of the Art. *Appl. Sci.* 2021, 11, 6800. [CrossRef]
6. Bekele, M.K.; Champion, E.; McMeekin, D.A.; Rahaman, H. The Influence of Collaborative and Multi-Modal Mixed Reality: Cultural Learning in Virtual Heritage. *Multimodal Technol. Interact.* 2021, 5, 79. [CrossRef]
7. Besoain, F.; Jego, L.; Gallardo, I. Developing a Virtual Museum: Experience from the Design and Creation Process. *Information* 2021, 12, 244. [CrossRef]
8. Jego, L.; Gallardo, I.; Besoain, F. Developing a Virtual Reality Experience with Game Elements for Tourism: Kayak Simulator. In Proceedings of the 2019 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILECON), Valparaiso, Chile, 13–27 November 2019; pp. 1–6. [CrossRef]
9. Rahaman, H. Photogrammetry: What, How, and Where. In *Virtual Heritage: A Guide*; Champion, E.M., Ed.; Ubiquity Press: London, UK, 2021; pp. 25–37. [CrossRef]
10. Jégó, L.; Aliaga, C.; Besoain, F. A framework for digitizing historical pieces for the development of interactive software. In Proceedings of the 2019 IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies (CHILECON), Valparaiso, Chile, 13–27 November 2019; pp. 1–6. [CrossRef]
11. Museo Nacional de Historia Natural Digitaliza Colecciones en 3D. Available online: https://www.patrimonio-cultural.gob.cl/noticias/museo-nacional-de-historia-natural-digitaliza-colecciones-en-3d (accessed on 10 October 2021).
12. Sketchfab | MNHN Chile. Available online: https://sketchfab.com/MNHNcl (accessed on 10 October 2021).
13. Champion, E. (Ed.) Virtual Heritage; Ubiquity Press: London, UK, 2021; p. 153. [CrossRef]
14. Loaiza Carvajal, D.A.; Morita, M.M.; Bilmes, G.M. Virtual museums. Captured reality and 3D modeling. *J. Cult. Herit.* 2020, 45, 234–239. [CrossRef]
15. Tzima, S.; Styliras, G.; Bassounas, A. Revealing Hidden Local Cultural Heritage through a Serious Escape Game in Outdoor Settings. *Information* 2021, 12, 10. [CrossRef]
16. Schweibenz, W. The virtual museum: An overview of its origins, concepts, and terminology. *Mus. Rev.* 2019, 4, 1–29.
17. Oculus Go: Standalone VR Headset | Oculus. Available online: http://web.archive.org/web/20190607051256/https://www.oculus.com/go/ (accessed on 7 July 2019).
18. Oculus Quest 2 | Oculus. Available online: https://web.archive.org/web/20210217103845/https://www.oculus.com/quest-2/ (accessed on 7 July 2019).
19. Slater, M. A note on presence terminology. *Presence Connect.* 2003, 3, 1–5.
20. Bowman, D.A.; McMahan, R.P. Virtual reality: How much immersion is enough? *Computer* 2007, 40, 36–43. [CrossRef]
21. Petty, R.E.; Cacioppo, J.T. The elaboration likelihood model of persuasion. In *Communication and Persuasion*; Springer: Berlin/Heidelberg, Germany, 1986; pp. 1–24.
22. Killea, L.A.; Johnson, B.T. Experimental induction of biased systematic processing: The directed-thought technique. *Personal. Soc. Psychol. Bull.* 1998, 24, 17–33. [CrossRef]
23. Fabrigar, L.R.; MacDonald, T.K.; Wegener, D.T. The Structure of Attitudes. In *The Handbook of Attitudes*; Albarracín, D., Johnson, B.T., Zanna, M.P., Eds.; Lawrence Erlbaum Associates: Mahwah, NJ, USA, 2005.
24. Albarracin, D.; Johnson, B.T.; Zanna, M.P. *The Handbook of Attitudes*; Psychology Press: Hove, UK, 2014.
25. Briñol, P.; Petty, R.E. Persuasion: Insights from the self-validation hypothesis. *Adv. Exp. Soc. Psychol.* 2009, 41, 69–118.
26. Eagly, A.H.; Chaiken, S. *The Psychology of Attitudes*; Harcourt Brace Jovanovich College: San Diego, CA, USA, 1993.
27. Eagly, A.H.; Chaiken, S. The advantages of an inclusive definition of attitude. *Soc. Cogn.* 2007, 25, 582–602. [CrossRef]
28. Brinol, P.; Petty, R.E. Self-Validation Theory: An Integrative Framework for Understanding When Thoughts Become Consequential. *Psychol. Rev.* 2021. [CrossRef]

29. Greenwald, A.G. Cognitive learning, cognitive response to persuasion, and attitude change. In *Psychological Foundations of Attitudes*; Academic Press Inc.: New York, NY, USA, 1968; pp. 147–170.

30. Brinol, P.; Petty, R.E.; Guyer, J.J. A historical view on attitudes and persuasion. In *Oxford Research Encyclopedia of Psychology*; Oxford University Press (OUP): Oxford, UK, 2019.

31. Tussyadiah, I.P.; Wang, D.; Jia, C.H. Virtual reality and attitudes toward tourism destinations. In *Information and Communication Technologies in Tourism 2017*; Springer: Berlin/Heidelberg, Germany, 2017; pp. 229–239.

32. Mütterlein, J.; Hess, T. Immersion, presence, interactivity: Towards a joint understanding of factors influencing virtual reality acceptance and use. In Proceedings of the 23rd Americas Conference on Information Systems (AMCIS), Boston, MA, USA, 10–12 August 2017.

33. Witmer, B.G.; Jerome, C.J.; Singer, M.J. The factor structure of the presence questionnaire. *Presence Teleoperators Virtual Environ.* 2005, 14, 298–312. [CrossRef]

34. Steuer, J. Defining virtual reality: Dimensions determining telepresence. *J. Commun.* 1992, 42, 73–93. [CrossRef]

35. Tussyadiah, I.P.; Wang, D.; Jung, T.H.; tom Dieck, M.C. Virtual reality, presence, and attitude change: Empirical evidence from tourism. *Tour. Manag.* 2018, 66, 140–154. [CrossRef]

36. Museo Virtual del Maule | Laboratorio Mauletec Chile. Available online: https://www.microsoft.com/es-cl/p/museo-virtual-del-maule/9pk32gvfkr2h (accessed on 10 October 2021).

37. Brinol, P.; Petty, R.E.; Tormala, Z.L. Self-validation of cognitive responses to advertisements. *J. Consum. Res.* 2004, 30, 559–573. [CrossRef]

38. Cialdini, R.B.; Petty, R.E.; Cacioppo, J.T. Attitude and attitude change. *Annu. Rev. Psychol.* 1981, 32, 357–404. [CrossRef]

39. Brinol, P.; Horcajo, J.; Becerra, A.; Falces, C.; Sierra, B. Cambio de actitudes implícitas. *Psicothema* 2002, 14, 771–775.

40. Brinol, P.; Horcajo, J.; Becerra, A.; Falces, C.; Sierra, B. Equilibrio cognitivo implícito. *Psicothema* 2003, 15, 375–380.

41. Falces, C.; Brinol, P.; Sierra, B.; Becerra, A.; Alier, E. Validación de la escala de necesidad de cognición y su aplicación al estudio del cambio de actitudes. *Psicothema* 2001, 13, 622–628.

42. Yun, E. Introducing the Thought-Listing Technique to Measure Affective Factors Influencing Attitudes toward Science. *Univ. J. Educ. Res.* 2020, 8, 2245–2250. [CrossRef]

43. Slater, M.; Usoh, M.; Steed, A. Depth of presence in virtual environments. *Presence Teleoperators Virtual Environ.* 1994, 3, 130–144. [CrossRef]

44. Witmer, B.G.; Singer, M.J. Measuring presence in virtual environments: A presence questionnaire. *Presence* 1998, 7, 225–240. [CrossRef]

45. Brinol, P.; Becerra, A.; Gallardo, I.; Horcajo, J.; Valle, C. Validación del pensamiento y persuasión. *Psicothema* 2004, 16, 606–610.

46. Hayes, A.F. Partial, conditional, and moderated moderated mediation: Quantification, inference, and interpretation. *Commun. Monogr.* 2018, 85, 4–40. [CrossRef]

47. Green, M.C.; Brock, T.C. The role of transportation in the persuasiveness of public narratives. *J. Personal. Soc. Psychol.* 2000, 79, 701. [CrossRef]

48. Horcajo, J.; Brinol, P.; Petty, R.E. Consumer persuasion: Indirect change and implicit balance. *Psychol. Mark.* 2010, 27, 938–963. [CrossRef]