Cultural Presence in Virtual Archaeology: An Exploratory Analysis of Factors

Abstract

Shared between Human–Computer Interaction and Cultural Heritage, the concept of Cultural Presence may provide an encompassing theoretical and methodological framework for Virtual Archaeology. The factors underlying presence have been extensively investigated, by means of both particular analyses as well as general statistical approaches. Yet, Cultural Presence has mostly been defined theoretically, and there are no global empirical examinations of it. The goal of this study is to verify the validity of the concept and to understand its underlying factors in the field of Virtual Archaeology. To that end we established an operational definition of Cultural Presence, we built a virtual reconstruction of an archaeological site based on it, and we evaluated the environment by means of self-reports and exploratory factor analysis. The general conclusion is that the concept of Cultural Presence is sound and composed of three main factors (cultural representation and engagement, social presence, and communicational aspects of technology); yet, it is not universal, but influenced by purpose and demographic variables.

1 Introduction

In the last ten years, Virtual Archaeology has become a well-established area at the intersection of the wider fields of Cultural Heritage and Digital Technologies. An important milestone was the establishment in 2011 of the Seville Principles (López-Menchero, 2013), a concretization for Archaeology of the more general “London Charter for the Visualization of Cultural Heritage” (Denard, 2012). The document starts by defining Virtual Archaeology as “the scientific discipline that seeks to research and develop ways of using computer-based visualization for the comprehensive management of archaeological heritage.” Subsequently, the Principles open the way for different kinds of application, contexts of use, purposes, and methodologies. However, many projects still consist of 3D photorealistic reconstructions of architectural remains aimed at learning, which seem to be based on two implicit assumptions: firstly, that photorealistic perspectivism is a universal “didactic method”; secondly, that architecture is a scientifically objective depiction and is representative of a whole culture.

Unfortunately, evaluation is not yet a systematic practice in Virtual Archaeology, but previous studies conducted in this and other fields have shown that photorealism can sometimes be counterproductive for understanding (Alessi,
1988; Gooch & Gooch, 1999; Lee, Park, & Kim, 2005; Pujol, 2011), and that empty architectural 3D models generate only superficial knowledge about specific recognizable elements (Bonini, 2008; Ibrahim, Mohamad Ali, & Mohd Yatim, 2015; Pujol & Economou, 2008). This poses the need for Virtual Archaeology to develop, as any other knowledge domain, well-grounded theoretical and methodological framework(s) for design and evaluation.

One potential framework may be based on the concept of Cultural Presence. It was initially defined in the field of presence (Riva, Castelnuovo, Gaggioli, & Mantovani, 2002; Spagnolli, Varotto, & Mantovani, 2003), and then introduced in Cultural Heritage (Champion, 2005, 2007, 2015; Pujol & Champion, 2012). A few direct applications were developed in both fields (Bonini, 2008; Devine, 2007; Jacobsen & Holden, 2007; Jones, 2005; Villani, Repetto, Cipresso, & Riva, 2012), and several other projects can be indirectly related with the concept (e.g., Garau, Slater, Pertaub, & Razzaque, 2005; Gorini et al., 2001; Greeff & Lalioti, 2001; Ribbens & Maillet, 2010; Turner & Turner, 2006; Turner, Turner, & Burrows, 2013). However, Cultural Presence was never investigated from a global empirical perspective: comprehensive exploratory analyses were exclusively devoted to the general concept of presence (e.g., Baños et al., 2000; Lessiter, Freeman, Keogh, & Davidoff, 2001; Lombard, Ditton, & Weinstein, 2009; Schubert, Friedmann, & Regenbrecht, 2001).

The convergence between presence and Cultural Heritage opens the way for the epistemological development of both fields: on the one hand, Virtual Archaeology integrates a well-grounded theoretical and methodological foundation; and on the other, presence (Klimmt & Vorderer, 2003; Turner & Turner, 2002) expands its analytical scope with the specific context and goals of Cultural Heritage. The aim of [LEAP], a two-year Marie Skłodowska-Curie Action funded by the European Union (Learning of Archaeology through Presence, FP7-PEOPLE-2013-IEF n. 625537, www.upf.edu/leap), was precisely to develop this crossroad area by means of a three-step process: 1) to import and expand the concept of Cultural Presence; 2) to build a VR-mediated experience of an archaeological culture; and 3) to evaluate the experience in order to a) verify the reality of the concept, b) compare its manifestation in different kinds of models, and c) test its suitability for learning.

This article will focus on the first goal of the evaluation, that is, the validity of the concept of Cultural Presence in Virtual Archaeology, and the factors underlying it. To that end, it will first review previous studies related to the empirical validation or the statistical characterization of Cultural Presence. Then, it will describe the main components of the study: operational definition of the term, experimental virtual environment, and evaluation procedure. Next, it will present the results of the statistical analyses, and it will discuss their implications for the definition of Cultural Presence. Finally, the article will summarize the conclusions of the study and present future lines of research.

2 Theoretical Definitions of Cultural Presence

Presence is a highly interdisciplinary field of research, at the confluence of psychology, computer graphics, and human–computer interaction. Although its theoretical foundations, methodologies, and focuses of interest have diversified over time, a simple definition formulated in the early nineties (Heeter, 1992; Reeves, 1991) remains at the core of them all: Presence corresponds to the “feeling of being there (together).” This motto encapsulates the evolution of the field, which could be roughly summarized in three successive phases: technological capacities (“being there”), subjective impressions/responses (“feeling”), and social affordances (“together”).

The term Cultural Presence was coined in the early 2000s. Arising from previous works (Mantovani & Riva, 1999; Zahrnik & Jenison, 1998), it defined a culturally meaningful environment in/with which users could interact and cooperate (Riva et al., 2002; Spagnolli et al., 2003). The important thing was no longer the result and the apparently unmediated similarity to the real world, but the process and the capacity to extract meaning. For this reason, it implied the pre-existence of a “cultural framework” influencing the expectations and interpretation of a virtual environment, and it required the recognition of mediation, ambiguity, and...
negotiation. Cultural Presence was “the feeling of being and making sense there together” (Villani et al., 2012).

The concept was imported into the Cultural Heritage field by Erik Champion (2005), and was subsequently developed through several publications (Champion, 2007, 2015; Pujol & Champion, 2012). Cultural Presence corresponded to the feeling of “being there and then (together),” that people belonging to a specific culture occupied, or had occupied in the past, a (virtual) environment. This implied coherence in behaviors and material objects, as well as agency, consciousness, and ambiguity (Champion, 2007). In the new domain, (Cultural) Presence was not the goal, but a means to serve the different evolving purposes of Cultural Heritage: learning, awareness, conservation, identity building, etc. This might be achieved through exploration, interpretation, and social exchange (Pujol & Champion, 2012), which depended on the “hermeneutic richness” of the environment (Champion, 2015).

The definition adopted by the [LEAP] project merged the previous definitions into the notion of “being and making sense there and then together.” This captures the general aim of achieving understanding that, based on the literature (e.g., Falk & Dierking, 2013; Hooper-Greenhill, 1994; Hooper-Greenhill et al., 2003), underlies most activities in Cultural Heritage, as well as the active communicational approach needed to ensure it. However, previous authors (Pujol & Champion, 2012) had raised doubts about the universality of the notion of culture, and advocated for the situatedness of its manifestation and interpretations. Therefore, instead of trying to implement and test a general concept of Cultural Presence, we defined a specific version arising from a chosen case of study: [LEAP] worked on the Neolithic site of Çatalhöyük in Turkey (www.catalhoyuk.com, see Figure 1), and with the help of site specialists (see Section 4.2), it defined the essential features of Çatalhöyük as a culture and how to depict them by means of VR (Pujol, 2017).

3 Related Work

To our knowledge there are no studies that have purposefully investigated Cultural Presence from a global empirical perspective. On the one hand, there are papers that deal with specific aspects that have been or can be related to Cultural Presence (social presence, sense of place, realism, authenticity, narrative and emotions). On the other, there are statistical investigations about the underlying factors of the general feeling of presence. In both cases, we have selected the most representative to be discussed here.

In relation to the first group of contributions, Villani et al. (2012) compared (t-test, ANOVA, and Linear Regression) the levels of presence and anxiety in a real versus simulated virtual job interview. While the former took place in a neutral environment, the latter had been designed based on people’s expectations. The results (obtained with questionnaires and Skin Conductance measurement) confirmed the importance of social/cultural cues, and refuted the need of the illusion of nonmediation proposed by Lombard and Ditton (1997).

Garau et al. (2005) investigated aspects related to Social Presence (Schroeder, 2002; Swinth & Blascovich, 2002), which according to Riva et al. (2002) is a factor contributing to Cultural Presence. Garau et al. verified what features synthetic characters should have in order for users to respond as if they were real. To this end, they created different degrees of agent responsiveness and compared users’ responses in each condition by means of questionnaires and analyses of variance (ANOVA). They concluded that the important factors were visual and

![Figure 1. Building 49 at Çatalhöyük (Turkey).](http://direct.mit.edu/pvar/article-pdf/doi/10.1162/pres_a_00296/1836700/pres_a_00296.pdf)
behavioral realism, autonomy, and capacity of interaction with the user.

Turner and Turner (2006) studied the sense of place in virtual environments, which had been conceptualized in relation to (Cultural) Presence by Spagnolli and Gamberrini (2005). The results of self-reporting and descriptive statistics indicated the sense of place depended on visual aspects, attributed meanings, affordances, and social interaction. In a subsequent study (Turner, Turner, & Burrows 2013), the virtual environment was more evocative, and participants rated the different elements in terms of informativeness. The conclusion was that non-visually realistic reconstructions may trigger strong cognitive representations (Clark, 1997) that influence positively both the sense of presence and learning.

Ribbens and Maillet (2010) explored the perception of realism in digital games. Using self-report and factor analysis, they concluded that the components of realism in videogames were simulational realism, freedom of choice, character involvement, graphical qualities, subject authenticity, character authenticity, and social realism.

Gorini et al. (2011) investigated the role of narration and immersion in the feeling of presence by means of self-report and heart rate measure. In their experiment, users were divided in four conditions: immersive/non-immersive and narrative/non-narrative. The results of a multivariate ANOVA evidenced that the highest level of presence appeared in the immersive and emotionally contextualized exploration of the environment.

Finally, Pujol and Champion (2012) reported on the results of previous studies analyzing the perception of virtual heritage environments by audiences. According to these investigations, game-like experiences curtailed the feeling of authenticity and hindered learning in some users, which indicated the lack of universality of synthetic simulations. These studies also showed that presence in the Cultural Heritage field seemed to be linked to richness of information, exploration of contents, meaningfulness/relevance, empathy, and historical accuracy.

The other set of related studies has to do with the statistical investigation of the factors underlying presence, which has been one of the central goals in presence research. While some studies have followed a correlational approach (Barfield & Weghorst, 1993; Witmer & Singer, 1998; Slater, Usoh, & Steed, 1994), another group of studies (reported here) has adopted an exploratory approach.

Baños et al. (2000) understood presence as similarity with the real world. To test the simulative capacity of virtual environments, they devised the Reality Judgment Presence Questionnaire (RJPQ), which was based on previous work (e.g. Slater et al., 1994; Steuer, 1992; Witmer & Singer, 1998) and comprised nine subscales. The result of factor analysis with Varimax rotation indicated three dimensions: reality judgment (a mix of perceptual realism, naturalness of interaction, and feeling of being there); internal/external correspondence (the system’s capability for interaction, navigation, responsiveness); and attention/absorption (involvement).

Schubert et al. (2001) considered presence as a mental construct arising from two elements: 1) the interpretation of internal and external stimuli related to the affordances of the virtual environment; and 2) the suppression of incompatible stimuli coming from the real world (attention). They built their IGroup Presence Questionnaire from previous well-assessed measurement tools (e.g. Slater et al., 1994; Witmer & Singer, 1998). The results of two exploratory and one confirmatory factor analyses indicated three main dimensions: spatial presence (feeling of “being and acting there”); attention (involvement); and realness (comparison between real and virtual world).

Lessiter et al. (2001) saw presence as a multidimensional subjective feeling, arising from both technical and human determinants. They built a questionnaire (“ITC-SOPI”) with 12 scales. The results of factor analysis with principal axes factoring revealed a four-factor structure comprising: sense of physical space (sense of being and acting there); engagement (involvement); ecological validity (believability, realness, and naturalness in comparison with the real world); and negative effects (adverse physiological reactions). This study is very similar to the previous one regarding the approach to presence and the inferred factors.

Lombard et al. (2009) did an extensive literature review and distinguished six types of presence, which could be gathered under the overarching notion of presence as the feeling of non-mediation. These types
constituted the different subscales of a cross-media questionnaire (“Temple Presence Inventory”). They performed a series of exploratory and confirmatory factor analyses, from which they concluded the main factors were: spatial presence (sense of being and acting there); para-social interaction (agency); passive social presence (observation of verbal and nonverbal communication in synthetic characters); active social presence (direct communication with or reactions from synthetic characters); presence as engagement; presence as social richness; presence as social realism; and presence as perceptual realism.

In conclusion, both groups of studies investigated or included issues that have an inherent cultural component, but they were studied in isolation and/or they were not considered from the cultural perspective. This article constitutes the first attempt to define and verify empirically the concept of Cultural Presence, acknowledging the previous findings and investigating them in the following manner: comprehensively (as components of Cultural Presence); purposefully (through a virtual environment built to convey the feeling of Cultural Presence); systematically (by means of a “Cultural Presence Questionnaire” and of exploratory factor analysis); from a comparative perspective (in relation to current 3D reconstructions); and with a specific context of application and purpose in mind (Cultural Heritage and learning).

4 The Study

4.1 Operational Definition of Cultural Presence

We consider Cultural Presence to be part of the general sense of presence. And following Schubert et al. (2001) we understand presence as a Gestalt and temporary condition of being, generated by physiological and psychological aspects. The physiological dimension corresponds to top-down behavioral responses (e.g., heart rate, skin response, and reflex movements) caused by the automatic processing of sensorial input. The psychological state arises from the subjective interpretation of a set of cognitive operations (e.g., comparison of mental models) involving the processing of external (e.g., interface and content) and internal (e.g., proprioception) sensorial stimuli.

Presence has usually been considered from an engineering perspective and therefore the operationalization of the concept has been based on (arguably) independent sets of causal factors. Technological factors refer to the capacity of the system to simulate or adapt to how we perceive and interact with the world. Human factors currently comprise our physical, cognitive, and psychological characteristics. However, as proposed by several authors (Riva et al., 2002; Villani et al., 2012) based on general theories of learning and perception (e.g., Bruner, 1990; Gibson, 1950; Vygotsky, 1978), the cultural background should be also taken into account. On the other hand, we would also add a third general category called “communicational factors.” All virtual environments are built with a specific purpose and context of application (learning, training, research, etc.), which determine their interface, content, and affordances for interaction. Despite its importance, this semiotic dimension of VR has been addressed from a conceptual perspective (Bettetini, 1991; Pujol, 2007; Tzortzaki, 2001), but has been mostly overlooked in empirical presence research (Parés & Parés, 2006; Riva et al., 2002; Turner & Turner, 2002).

To complete the operationalization of the concept of Cultural Presence, we divided the aforementioned definition into a set of components (see Table 1), which we linked (with the help of presence literature) to a series of causal factors. These in turn were translated into measurable counterparts. In our opinion, while the causal categories are high-level enough to be considered universal, the aspects analyzed at a lower level should be specific of each study (depending on its goals and context of application). For example, in our case, users’ physical characteristics were taken for granted (since they are integrated in the human factors underlying the off-the-shelf interfaces). On the other hand, since all participants belonged to the same country, we considered more relevant to measure the cultural background in terms of professional experience.

4.2 The Virtual Environment

The virtual environment created in the context of the [LEAP] project consists of a synthetic reconstruction
of the Neolithic site of Çatalhöyük in Turkey. “ÇH3D” was built with 3D Studio Max and Unity Game Engine. To define the content, we held a series of workshops with site specialists, described in (Pujol, 2017). As a result, the experience consists of a one-day trip to Çatalhöyük 9000 years ago, during which users can navigate five consecutive pre-defined points of interest (two inside a house and three at different points on the settlement) depicting specific tangible and intangible cultural features. The experience has two display modes, immersive and screen-based, and requires light equipment (gaming laptop, HMD, earphones, and gamepad).

The model has six increasingly “complete” versions or experimental conditions (see Figure 2): architecture only, objects, hotspots with written information, still characters, dynamic scenes with sound, and narration. They contain the same cultural information, the same level of interaction (navigation), and the same diversity

### Table 1. Operationalization of the Concept of Cultural Presence

<table>
<thead>
<tr>
<th>Components</th>
<th>Factor</th>
<th>Aspect analyzed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective interpretation</td>
<td>Purpose</td>
<td>Learning.</td>
</tr>
<tr>
<td>Cultural background</td>
<td></td>
<td>Usefulness; Authenticity; Interest in archaeology.</td>
</tr>
<tr>
<td>Cognitive operations</td>
<td>General cognitive characteristics</td>
<td>Imagination; Suspension of disbelief; Willingness to experience presence; Attention; Age.</td>
</tr>
<tr>
<td></td>
<td>Task-specific cognitive characteristics</td>
<td>Technological skills; Professional background; Previous experience with computers, games and immersive VR; Age.</td>
</tr>
<tr>
<td>External input</td>
<td>Psychological traits</td>
<td>Emotions; Gender; Age.</td>
</tr>
<tr>
<td>User’s physical characteristics</td>
<td></td>
<td>Human factors underlying the system.</td>
</tr>
<tr>
<td>Technological capacity to simulate human perception, interpretation of, and interaction with the world</td>
<td>Quantity and quality of sensory stimuli; Extension and naturalness of interaction; Virtual environment’s behavior; Social and cultural content.</td>
<td></td>
</tr>
<tr>
<td>Internal input</td>
<td>User’s physical characteristics</td>
<td>Human factors underlying the system.</td>
</tr>
<tr>
<td>Technological capacity to trick human proprioceptors and vestibular system</td>
<td>Self-perception.</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 2. From left to right, Çatalhöyük's Building 49 as depicted in experimental conditions 1 (architecture only), 3 (hotspots with information), and 5 (dynamic scenes).](image-url)
of perceptual realism (textures and scientific veracity). The reason for creating six versions and not a single virtual environment fully deploying our definition of Cultural Presence was to serve the multiple goals of the project while addressing the current state of the art of archaeological reconstructions: as previously said, little is known about the outcomes of current hyperrealistic, purely navigable 3D models.

4.3 The evaluation

To accomplish the multiple goals of the evaluation, we designed a between-subjects experiment. To reduce the number of intervening variables, only the HMD mode was used. Participants were initially assigned randomly to one of the six versions of ÇH3D. After following the standard ethics protocol, they filled in a pre-experience questionnaire. Then, instructions about the procedure and the virtual environment were given, and participants could explore (their version of) ÇH3D at will, while being recorded. They were encouraged to think aloud and could ask for help if needed. After the experience, they filled in a second questionnaire.

Since we define the “feeling” of presence as a Gestalt condition arising from the interpretation of cognitive processes based on external and internal sensory information, we considered questionnaires to be the most suitable measurement tool. The first form contained 20 questions, mostly related to demographic variables, previous knowledge, interests, skills, and attitudes. The post-experience form corresponded to the purposefully designed Cultural Presence Questionnaire (CPQ). It comprised 98 items divided into 10 subscales, arising from the operational definition of Presence: General Presence, Perception, Self-perception, World’s authenticity and behavior, Interaction, Attention, Willingness to experience presence, Suspension of disbelief, Emotions, Social Presence, and Culture. Some scales, like Perception, Attention, or Social Presence were based on previous questionnaires (Baños et al., 2000; Lombard et al., 2009; Ribbens & Maillet, 2010; Schubert et al., 2001; Slater et al., 1994; Watson & Clark, 1994; Witmer & Singer, 1998); others, like Culture and Social Presence were created from scratch.

Figure 3. A user experiencing ÇH3D (Condition 1) during evaluation.

After a period of pilot testing, data gathering (see Figure 3) lasted one month (July 2016) and was conducted either at the premises of Pompeu Fabra University or at the participant’s location. We recruited 84 users (14 by condition). Our average user was a woman, without academic specialization, between 30–39 or 40–59 years old, using computers daily, but playing games less than once a month. She had never experienced virtual reality, had moderate interest in archaeology, and average technological skills.

5 Statistical analyses

In order to verify the validity of the concept of Cultural Presence in Virtual Archaeology and unravel its components, we used exploratory factor analysis (EFA). We established the hypotheses that 1) cultural variables would be fundamental, 2) they would be closely linked to social aspects, and 3) they would be more important than sensorial realism.

5.1 Preparing for Factor Analysis

Before any analysis, we conducted a series of tests to verify the adequacy of our sample, measurement tool, and data. Most publications recommend a minimum sample of 100 participants, which we were not able to reach for practical reasons. However, robustness can be also ensured by means of ratios. The advised ratio subjects-to-variables is 2:1 and the ratio subjects-to-factors is 20:1. Our ratios were, respectively, 2.7:1 and 28:1.
We also performed a reliability analysis (Cronbach’s alpha and correlation matrix) to test the internal consistency of our scales. Items were temporarily retained if they had a relatively high alpha, their matrix coefficient was above 0.3, and they did not correlate internally with other variables with higher results. Attention and perception (taken from other questionnaires) were problematic because they comprised very diverse variables which behaved differently across conditions. We solved the issue by separating these variables into new subscales (e.g., visual/auditory, positive/negative).

Finally, we ran a principal components analysis (direct oblimin rotation method; 34 iterations; automatic number of extracted components). This allowed two things. On the one hand, it helped decide the number of factors in the future EFA: the Scree plot indicated three factors, which were confirmed with a Montecarlo simulation of Eigenvalues. On the other hand, it helped refine the selection of items. In this case, we compared the results of the correlation analysis with the pattern matrix and the communalities in a first, preliminary 3-factor EFA, and we discarded the variables that loaded under 0.3 and in the last factors. The fact that all variables in Social Presence, Sound, Willingness to experience presence, and Culture loaded in the same factor confirmed the reliability of these scales.

### 5.2 General Factor Analyses

All our EFAs were performed with principal axes (an extraction method that looks for the minimum number of factors accounting for the common variance) and direct oblimin (a rotation method used when the independence of factors cannot be assumed).

The first EFA included all subscales except General Presence, which had been built for comparative purposes. Bartlett’s test of sphericity was significant; but most importantly the Keyser-Meyer-Olkin (KMO) test reached 0.704, which indicates a good sampling adequacy ($N = 70$). The total variance explained was 40%. Correlations between factors were low, which means they were orthogonal, and loadings were quite exclusive, which shows factors were well defined.

![Figure 4](general-factor-analysis.png)

**Figure 4.** General factor analysis.

The first factor (see Figure 4) contained: all Emotions (positive and negative), all variables linked to visual aspects (perception, device, attention), all variables in World’s authenticity and behavior, all variables from Culture, willingness to be transported to the past, and the two variables of Interaction that have to do with realism (navigation and exploration of elements). The second factor was clearly related to Social Presence, as all variables belonging to this scale loaded here. The auditory aspects of Perception were also comprised in this factor, which is normal because they are linked to the presence of human characters (except for condition 4). Finally, the third factor had to do with the attentional and practical aspects of Interaction.

Contrary to what we expected, cultural and social aspects loaded in different factors, which means they
were not linked. Intrigued by this result, we decided to eliminate the scale Emotions and investigate further the nature and validity of Cultural Presence with more relevant variables. This is because in the correlation matrix emotions showed associations mostly to visual realism and intuitiveness of interaction, that is, an awe effect probably generated by the novelty of the experience.

The second EFA (KMO = 0.692; N = 72; variance explained = 39.04%; n. of factors = 3) confirmed the previous results (see Figure 5). Factor 1 comprised all variables in Culture, in World’s authenticity and behavior, and in Willingness to experience presence. It also contained absorption. Social Presence and the auditory aspects of Perception loaded again in Factor 2. And Factor 3 was again completely related to Interaction (practical and attentional). Yet, it comprised all visual aspects (perception, device, and attention). This seemed to confirm that cultural aspects were not linked to the presence of human characters, but to features of the virtual environment, the willingness to travel to the past, and engagement. On the other hand, visual aspects had a marginal role, linked to the capacities of technology.

The correlation matrix would provide further insight into these matters. With regard to social aspects, the presence of autonomous people was linked to the feeling of an inhabited place where daily life goes on. The realism of characters depended on visual realism and naturalness of interaction. With regard to cultural aspects, the feeling of visiting an inhabited place was linked to the presence of autonomous characters, absorption, and the autonomy of the environment; the feeling of visiting a specific culture was linked to cultural plausibility, absorption, and visual realism; the perception of specific cultural traits depended on scientific authenticity, cultural plausibility, and the world’s autonomy; finally, the feeling of seeing everyday life was provided by absorption, the presence of autonomous characters, and the virtual environment.

5.3 Introducing the Experimental Condition

To further explore the previous findings, we performed a new EFA including the variable “Condition” (KMO = 0.698; N = 72; variance explained = 46.24%; n. of factors = 4). With the new analysis, we wanted to see if the type of virtual environment influenced the factors underlying Cultural Presence.

The main associations between scales and factors remained (see Figure 6): cultural and environmental aspects loaded in Factor 1, together with absorption and willingness to be transported to the past; Social Presence loaded in Factor 2; and the different aspects of interaction and visual perception loaded in Factor 3.
“Condition” was strongly associated with Social Presence in Factor 2, and with the auditory aspects, which had moved to Factor 4 because they are present in only a couple of conditions. The introduction of the experimental condition also highlighted some transversal items: Feeling of seeing everyday life, Naturality of navigation, Visual realism, and Exploration of elements. Finally, the correlation matrix indicated the exact same associations for the social and cultural subscales we had seen in the previous EFA.

### 5.4 Introducing Demographic Variables

In the next test, we checked potential influences of demographic variables (see Figure 7). In order to select the relevant demographic variables, we performed several ANOVAs to look for significant differences between means. The following differences emerged:

- “Expertise in related field” for “Visiting another culture”: $F(5,16) = 2.988; p = 0.043$.
- “Experience with immersive VR” for “Experimental Condition 2”: $F(3,10) = 4.459; p = 0.031$.
- “Use of games” for “Similarity to the real world”: $F(4.77) = 2.599; p = 0.042$.
- “Suspension of Disbelief” (SoD) for “Being at Çatalhöyük in the Neolithic”: $F(2,79) = 3.526; p = 0.034$.

Consequently, the first “demographic EFA” included Expertise in related field (KMO = 0.668; N = 72;
The second “demographic EFA” included Experience with immersive VR (KMO = 0.665; N = 72; explained variance = 44.04%; n. of factors = 4). The factor structure reproduced the previous one: Culture, virtual environment, absorption, and visual perception in Factor 1, Social Presence and the auditory aspects in Factor 2, and interaction variables in Factor 3. Experience loaded high in Factor 3, which means people who had previously seen immersive VR expected to have the possibility to explore the virtual environment by means of natural interaction.
The third “demographic EFA” included Use of computer games (KMO = 0.676; N = 72; explained variance = 44.02%; n. of factors = 4). The factor structure remained unchanged and the new variable appeared as a crossloading of the first factor. The correlation matrix indicated these participants judged negatively the performance of the display device, the autonomy of the environment, its visual realism, and the feeling of seeing everyday life; on the other hand, they judged positively its scientific authenticity.

The last “demographic EFA” included Suspension of disbelief (KMO = 0.683; N = 71; explained variance = 44.44%; n. of factors = 4). Again, the factor structure remained unchanged and the new variable appeared as a crossloading of the second factor. This means that participants who could easily deactivate their incredulity were more prone to take human characters in CH3D as “real.”

5.5 Confirming Cultural Presence

In the final test we included the General Presence subscale (KMO = 0.718; N = 72; variance explained = 45.07%; n. of factors = 4). The aim was to confirm previous results regarding factor structure and specific associations.

Logically (see Figure 8), all items in the General Presence subscale loaded in the first factor, where we found also the cultural, environmental, attentional, and visual variables. The second factor had to do with Social Presence. The third was linked to interaction. The fourth contained the auditory aspects.

In the correlation matrix (see Figure 9), the associations of social aspects matched previous EFAs, except for Presence of autonomous characters, which was associated with Being at the Neolithic. The cultural subscale also behaved as in previous analyses, but showed a stronger relation with the General Presence items. This is normal if we consider that the variables in both subscales were similar. More relevant for our purposes are the associations of the General Presence scale with other subscales. In this case, the feeling of having traveled to the Neolithic was linked to Visual realism, natural navigation, absorption, and visiting a specific culture. The feeling of visiting a place was again associated with Visual realism, specific culture, the autonomous virtual environment, and Immersion. The feeling of a distinct culture had to do with cultural plausibility, absorption, and again, visiting a specific culture. Finally, the similarity of the virtual environment with the real world was linked to Visual realism, Immersion, absorption, and natural navigation.

6 Discussion

The previous results indicate the feeling of Cultural Presence was strongly linked to emotions (feeling excited, surprised, interested), attention, the plausibility and behavior of the virtual environment, and cultural aspects. Social Presence had a secondary role: the presence of people contributed to the feeling of an inhabited, lively place but in their absence, the autonomy of the virtual environment and the capacity of the experience to absorb people’s attention became determinant factors. These were also fundamental, together with the environment’s cultural and scientific plausibility, in the feeling of seeing a specific culture with specific cultural traits.

On the other hand, there were some aspects (exploration, visual realism, and immersion) that appeared to be transversal but especially linked to technology. And to demographic variables: experts judged the environment in terms of its communicational potential; gamers were not truly moved by the experience, but appreciated its epistemological value; users with previous VR experience expected to have the possibility to explore the virtual environment by means of natural interaction; finally, human characters were more appreciated by users who could easily suspend disbelief. In any case, the feeling of Cultural Presence was the result of an array of variables related with the way we perceive, focus on, and interact with the world, with the addition of cultural specificity and an epistemological component.

These results confirm the conclusions of Pujol and Champion (2012) regarding the non-equivalence of Cultural and Social Presence, the lack of universality of the concept of Cultural Presence, the secondary role of visual realism, the importance of scientific authenticity and affordances for exploration, and the influence of user
characteristics. The later elements were also emphasized by Villani et al. (2012), who labeled them as user expectations and social cues. Our results also corroborate Garau et al.’s (2005) findings about the importance of autonomy and visual and behavioral realism in human characters. Realism was the main focus in Ribbens and Maillet (2010): we also found that simulative realism, subject authenticity, social realism, character authenticity, and visual realism were relevant aspects of Cultural Presence, under the names of exploration of elements, scientific authenticity, realistic characters (looks and behavior), and visual realism. The major differences had to do with the sense of place, explored by Turner and Turner (2006) and Turner et al. (2013). In our case, attentional and cultural components (absorption and cultural specificity) were more important than visual aspects (realism and immersion). On the other hand, Social Presence and affordances for interaction were not linked to the sense of place but to the general feeling of Cultural Presence. Finally, our study could not confirm Gorini et al.’s (2001) findings regarding the importance of emotions in the feeling of presence because in our case they were linked to the novelty of the medium rather than to the content.

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visited a specific culture</td>
<td>0.723</td>
<td>0.016</td>
<td>0.039</td>
<td>0.026</td>
</tr>
<tr>
<td>VE was culturally plausible</td>
<td>0.716</td>
<td>-0.174</td>
<td>0.028</td>
<td>0.064</td>
</tr>
<tr>
<td>Visited another culture</td>
<td>0.070</td>
<td>0.006</td>
<td>0.007</td>
<td>-0.113</td>
</tr>
<tr>
<td>Being at Cth in the Neolithic</td>
<td>0.887</td>
<td>0.106</td>
<td>-0.081</td>
<td>-0.276</td>
</tr>
<tr>
<td>Visited a place</td>
<td>0.952</td>
<td>0.020</td>
<td>-0.043</td>
<td>-0.204</td>
</tr>
<tr>
<td>VE behaved autonomously</td>
<td>0.591</td>
<td>0.038</td>
<td>0.001</td>
<td>0.176</td>
</tr>
<tr>
<td>Visited an inhabited place</td>
<td>0.524</td>
<td>0.225</td>
<td>0.051</td>
<td>0.048</td>
</tr>
<tr>
<td>Perceived specific cultural traits</td>
<td>0.509</td>
<td>-0.055</td>
<td>0.018</td>
<td>0.156</td>
</tr>
<tr>
<td>Surrounded by visual aspects</td>
<td>0.466</td>
<td>-0.115</td>
<td>-0.329</td>
<td>-0.014</td>
</tr>
<tr>
<td>Feeling absorbed</td>
<td>0.451</td>
<td>0.210</td>
<td>-0.307</td>
<td>-0.003</td>
</tr>
<tr>
<td>Visual realism</td>
<td>0.440</td>
<td>0.185</td>
<td>-0.287</td>
<td>-0.244</td>
</tr>
<tr>
<td>VE scientifically authentic</td>
<td>0.426</td>
<td>-0.018</td>
<td>-0.146</td>
<td>0.095</td>
</tr>
<tr>
<td>VE similar to real world</td>
<td>0.419</td>
<td>0.062</td>
<td>-0.065</td>
<td>-0.161</td>
</tr>
<tr>
<td>Continuity of events</td>
<td>0.305</td>
<td>0.183</td>
<td>-0.141</td>
<td>-0.069</td>
</tr>
<tr>
<td>Willing to be transported to the past</td>
<td>0.296</td>
<td>0.044</td>
<td>0.128</td>
<td>-0.038</td>
</tr>
<tr>
<td>Feeling of seeing everyday life</td>
<td>0.286</td>
<td>0.256</td>
<td>-0.244</td>
<td>0.144</td>
</tr>
<tr>
<td>Characters behaved in a realistic way</td>
<td>-0.018</td>
<td>0.915</td>
<td>0.021</td>
<td>0.069</td>
</tr>
<tr>
<td>Characters looked realistic</td>
<td>0.040</td>
<td>0.908</td>
<td>0.125</td>
<td>-0.036</td>
</tr>
<tr>
<td>Autonomous characters</td>
<td>0.147</td>
<td>0.803</td>
<td>0.141</td>
<td>0.005</td>
</tr>
<tr>
<td>Presence of people</td>
<td>-0.072</td>
<td>0.768</td>
<td>-0.071</td>
<td>0.256</td>
</tr>
<tr>
<td>Reality of navigation</td>
<td>0.284</td>
<td>0.303</td>
<td>-0.299</td>
<td>-0.163</td>
</tr>
<tr>
<td>Feeling disoriented</td>
<td>0.017</td>
<td>0.136</td>
<td>0.797</td>
<td>-0.170</td>
</tr>
<tr>
<td>Control device interferes with navigation</td>
<td>-0.064</td>
<td>0.255</td>
<td>0.092</td>
<td>-0.054</td>
</tr>
<tr>
<td>Distraction by control device</td>
<td>-0.061</td>
<td>-0.010</td>
<td>0.061</td>
<td>-0.090</td>
</tr>
<tr>
<td>Experience disrupted by display device?</td>
<td>-0.005</td>
<td>0.225</td>
<td>0.399</td>
<td>0.182</td>
</tr>
<tr>
<td>Distraction by display device</td>
<td>0.082</td>
<td>-0.130</td>
<td>0.373</td>
<td>0.231</td>
</tr>
<tr>
<td>Exploration of elements</td>
<td>0.088</td>
<td>0.192</td>
<td>-0.302</td>
<td>-0.046</td>
</tr>
<tr>
<td>Auditory realism</td>
<td>0.176</td>
<td>0.324</td>
<td>0.160</td>
<td>0.783</td>
</tr>
<tr>
<td>Surrounded by auditory aspects</td>
<td>0.020</td>
<td>0.366</td>
<td>0.063</td>
<td>0.698</td>
</tr>
<tr>
<td>Willing to put themselves in the inhabitants’ shoes</td>
<td>0.116</td>
<td>0.096</td>
<td>0.133</td>
<td>-0.342</td>
</tr>
</tbody>
</table>

**Figure 8.** Factor analysis including the General Presence subscale.
With regard to global statistic approaches, our study confirmed the primary importance of engagement, stressed in Baños et al. (2000) and Schubert et al. (2001) and especially in Lombard et al. (2009). Scientific verisimilitude and believability of the virtual world, found in Lessiter et al. (2001), were also fundamental factors in our study, while social richness (Lombard et al., 2009) and realism of characters (Lessiter et al., 2001) had a secondary role. But this was probably an effect of the experimental conditions. What our study evidenced is the minor importance of interaction (Baños et al., 2000) and especially of perceptual realism (Baños et al., 2000; Lombard et al., 2009), which has been a fundamental element in presence research and current archaeological virtual reconstructions.

7 Conclusions and Future Work

This study arose from the need to endow Virtual Archaeology with an encompassing theoretical and methodological framework for the design and evaluation of virtual reconstructions. The [LEAP] project attempted to provide such foundation by developing and testing the concept of Cultural Presence, originally coined in the field of presence. Cultural Presence had been defined theoretically but never investigated empirically from a global perspective. Consequently, 1) we established a theoretical and operational definition of Cultural Presence; 2) we built a VR-mediated experience of the UNESCO World Heritage Neolithic site of Çatalhöyük in Turkey; and 3) we evaluated the experience from different perspectives. This article presents the results related to the statistical validation and characterization of the concept.

The consistent behavior of items across the different EFAs indicates Cultural Presence is a sound concept, and comprises the following underlying factors:

1. Cultural representation and engagement: attential absorption by an inhabited place, with specific cultural traits, where daily life goes on independently of the observer (autonomy of the environment and continuity of events), and which provides an overall sense of cultural distinctiveness, plausibility, and scientific authenticity.
2. Social presence: inclusion of autonomous characters that look and behave in a realistic way.

Perceptual aspects can be considered “mobile,” since they loaded in different factors depending on the circumstances. Auditory realism and immersion were closely associated with the presence of human characters, as a result of the experimental conditions. Therefore,
their role or meaningfulness cannot be extrapolated beyond the present research. But visual realism and immersion changed depending on users’ characteristics and attitudes toward the experience.

The results confirm our initial hypothesis that cultural aspects are more important than sensorial realism in the feeling of Cultural Presence, but there are two caveats. Firstly, they are not alone; there is also the contribution of simulational and attentional components (technological and human factors). Secondly, the social dimension is secondary and not closely linked to cultural aspects. In other words, the feeling of culture may arise from the presence of characters or from the environment’s appearance and behavior. However, this cannot be taken as a definitive, universal conclusion, since it may be an effect of the experimental conditions of this project. It is surely related to demographic variables (e.g., suspension of disbelief, field of expertise, and experience with games and immersive VR), which would confirm the importance of the cultural background as part of the human factors. Seemingly, the epistemological component in the feeling of Cultural Presence would confirm the importance of the semiotic or communicational factor proposed in Section 4.1.

The conclusions of this first empirical exploration of the concept of Cultural Presence open three main lines of future development. Firstly, given the strong association between Condition and Social Presence, it would seem that the experimental conditions may have biased the relation between Social and Cultural Presence. Their association needs to be tested again in a single, fully populated version of ÇH3D. Secondly, the behavior of visual realism seemed to indicate the influence of user variables in the feeling of Cultural Presence and/or the perception of virtual environments. New investigations should focus on the role of demographic variables (human factors) with statistical analyses such as ANOVAs, etc. The third line of future research has to do with the number of factors. Depending on the variables included, we had solutions with three or four factors. Following the recommendations of Waller and Bachmann (2006) and the example of Lombard et al. (2009) and Schubert et al. (2001), we should test the fitness of both possibilities with confirmatory factor analyses (CFA). CFA forces the researcher to choose a factor structure (i.e., make a hypothesis about the data) and provides a statistical measure of its difference with another possibility. This would help confirm and fine-grain the statistical definition of Cultural Presence.

The empirical verification and description of Cultural Presence has manifold implications for Virtual Archaeology. It establishes the cornerstone of a theoretical framework for the field. In contrast with current 3D models (mostly aimed at depicting architectural remains), it helps define how to represent past cultures by means of VR-mediated experiences. It provides a pipeline for design, as well as criteria for evaluation (factors and their relative importance). Moreover, unlike the current universal use of 3D models, it proves the context of application and end users should also be taken into account. All this should ultimately contribute to enhance the scientific and social role of Virtual Archaeology, along the lines defined by the Seville Principles, and more in general by the London Charter.

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