Article

Social Cohesion in Interactive Digital Heritage Experiences

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Abstract: Presently, social cohesion (SC) is a priority at different levels. Cultural heritage is an ideal context to promote SC through interactive digital technologies designed to engage groups of visitors. The purpose of the present study is to identify how to design digital heritage applications for SC and how to measure it. The results are based on the design of a cultural probe kit used to identify the design elements on top of which a collaborative and hybrid prototype, the Brancacci POV, was developed. Here, we analysed the results of this prototype, which included 107 visitors with respective groups of 5 participants and guided by an expert. From this analysis, the possibility of strengthening SC when collaborative tasks are included emerged. Additionally, it appeared to be possible to shorten the distance between citizens and cultural institutions if "mediated dialogue" approaches were adopted and if focus, motivation, trust and "in-group" perception of inclusion emerge when digital heritage experiences were set in intimate and quiet environments.

1. Introduction

> "*Man is by nature a social animal; an individual who is unsocial naturally and not accidentally is either beneath our notice or more than human. Society is something that precedes the individual. Anyone who either cannot lead the common life or is so self-sufficient as not to need to, and therefore does not partake of society, is either a beast or a god*" (Aristotle, Politics).

Many philosophers and thinkers, from Aristotle onward [1], have stated and discussed how human beings are social entities and, therefore, have a natural need to be part of a social group. Humans are part of different social groups, including nuclear families, classmates, friends and professional colleagues (in-groups). However, people tend to have less connections with groups that have different characteristics then them (out-groups). Being social, in the case of humans, relates to the capability to communicate, not only verbally but using facial expressions, gestures, tone of voice and accent, taking the role of others, mimicking behaviours, etc. [2]. Humans have the capacity to align behaviours, through imitation, to their social environment, making these behavioural characteristics a "social glue" [2] (p. 208). This social component is also part of tourism experiences. Moreover, this study seeks to extend this component to tourism, specifically cultural tourism, in order to provide virtual museum tours and other virtual tours [3,4], including those that involve the use of augmented reality (AR) and virtual reality (VR) [5].

Present studies and policies emphasise the key role of cultural participation for social cohesion, but there is still limited research on how to design virtual experiences for cultural tourism and museums for enhancing group cohesiveness. Given the lack of specific literature on this topic, the present work focuses on the assumption that cultural heritage can be a perfect ground to foster social cohesion (SC) through collaborative and multimodal technologies; specifically, our goal is to contribute and advance knowledge and interactive

media design practices, as well as to identify SC measurement methods. Our main research questions are as follows:

- How do we design multimodal applications that solicit SC? Which are the triggers of SC? How can we adopt and adapt those triggers to improve the design?
- How can we measure SC and specifically group cohesiveness in such applications?

2. Theoretical Background

2.1. SC in Social Studies and Policies

Since the early 2000s, the Council of Europe has adopted strategies to promote SC [6], which is defined as "the capacity of a society to ensure the well-being of all its members, minimising disparities and avoiding marginalization" [7] (p. 14), as a policy goal of the European Union.

As SC has been researched from many different disciplinary perspectives and with different scopes (from smaller groups to larger societal groups), there is a fragmented view of this complex construct [8]. For this study, we adopt the following definition, in which SC is defined as follows:

> "[. . .] *the ongoing process of developing well-being, sense of belonging, and voluntary social participation of the members of society, while developing communities that tolerate and promote a multiplicity of values and cultures and granting at the same time equal rights and opportunities in society*" (Fonseca et al., 2018, 246).

The Social Cohesion Radar (Figure 1) was developed in 2011 by the researchers of the Bertelsmann Stiftung (Foundation) as an empirical instrument for studying social interactions [9]. This radar served as a framework for successful studies on national and local levels [10,11] and is divided into three interconnected domains: social relations, connectedness and focus on the common good; each is subdivided into subdomains. For every subdomain, group cohesiveness indicators are identified. Although this radar has proven to be a very useful instrument, it has only been used to evaluate very wide groups (at regional or national levels) and never in the cultural heritage domain.
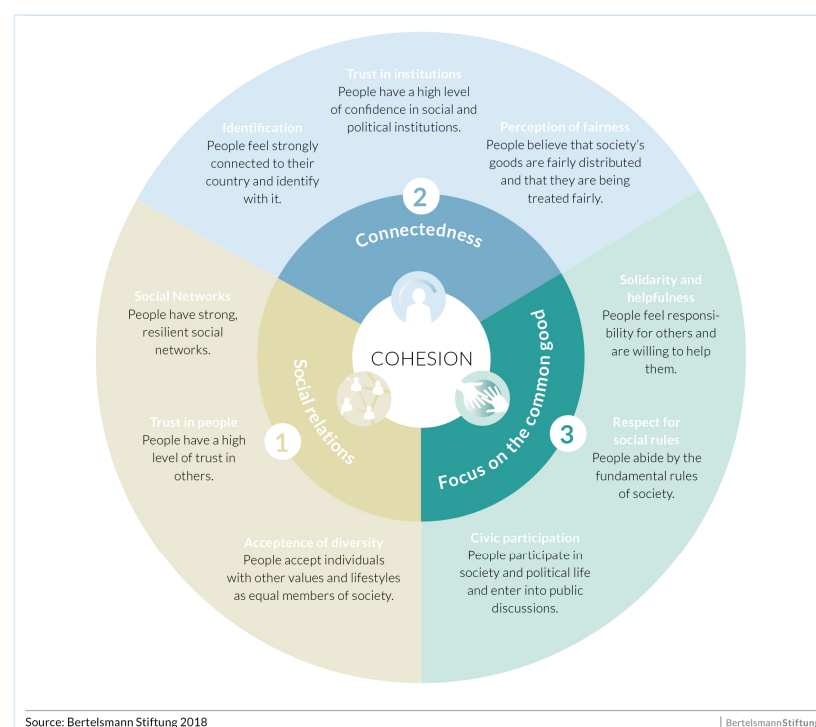
Figure 1. The Social Cohesion Radar (infographic available online [12], based on [9]).

SC represents an enduring priority of cultural policies, especially given the crucial role that culture plays in promoting it through civic participation in cultural heritage, creativity and the arts. Research has provided ample evidence of the effects of cultural participation on SC, in terms of prosocial behaviour, personal development and intercultural dialogue in socially critical territories, as is best illustrated by the case of collective musical education [13]. Further evidence on the role of cultural approaches for SC is provided through the analysis of participation to projects involving co-creation and arts-based methodologies [13].

The relevance of spillover effects of culture and creativity has been recognized by the New European Agenda for Culture adopted in May 2018 by the European Commission [14], which indicates "harnessing the power of culture and cultural diversity for social cohesion and wellbeing" as a key objective. Cohesion and wellbeing have also been among the priorities of the workplan for culture 2019–2022, which highlights the need for a better understanding of changing user behaviour and the needs of different audiences due to digitalization, ageing and culturally diverse societies [14]. In the new workplan [15], enhancing cultural participation represents a priority area for facilitating social and territorial cohesion, while also fostering respect for cultural diversity and open dialogue within civil societies.

2.2. SC in Digital Heritage

Despite the growing attention on the link between cultural participation and SC, limited research has been done to specifically address the use of digital interactive applications for promoting group cohesiveness.

Ciolfi emphasised the need to take an innovative perspective beyond the functional approach of conveying content towards facilitating the dialogue with groups through digital heritage interaction design that have an impact on SC [16].

This perspective is reflected in the EU-funded CultureLabs project, which explored the use of digital interactions with cultural heritage for empowerment, social inclusion and intercultural dialogue [17]. The project focused on digital technologies supporting dialogue with marginalized groups, including migrant communities, and highlighted the open challenges for embracing a greater and more diverse set of communities and perspectives for co-creation and social innovation.

Social inclusion of migrant communities has been also addressed within the European-funded project MEMEX, which aimed at promoting social inclusion by developing collaborative storytelling tools related to cultural heritage [18]. During the European project EMOTIVE, Perry [19] identified "facilitated dialogue" as one of the most promising methods to be used in digital media design to involve participants into complex reflections. She specifically discussed "dialogue-led methods" as they "can effectively prompt self-reflection and perspective-taking, leading to constructive alliance-building and democratic engagement with others". Perspective-taking and perspective-giving are two well-known approaches used to trigger empathy, even in conflictual situations [20].

Current research conducted within the SPICE project (social cohesion, participation and inclusion through cultural engagement) aims to promote SC through tools and methods that support citizen curation for groups at risk of exclusion. In this project, a specific focus is placed on the development of methods that strengthen empathy, which is intended as an intermediate step towards SC [21]. This study further detects empathy from interpretations and visitor comments through the combination of a personal user model and group visitor models.

The present research builds on these previous experiences and leverages the potential of multimodal technologies, enabling visitors to use various devices and interactive modalities, from full immersive VR with HMDs to smartphone interaction, from personal exploration to collaborative activities in hybrid environments, for strengthening social cohesion in the encounter with cultural heritage.

3. Methodology

For the purpose of this research, we adopted an exploratory approach based on a three-stage methodology (Figure 2): (a) the creation of a "Cultural Probe Kit" (CPK), based on the literature review and theoretical background, for the qualitative exploration of SC in the cultural heritage domain and the identification of triggers to be used as design indications and of measures for SC; (b) the introduction of specific design elements into a multimodal prototype (the Brancacci POV) [22]; (c) the analysis of this prototype, using the identified measures, to evaluate visitors' perception of SC, with a focus on ingroup contact, participation and reduction of out-group distance.
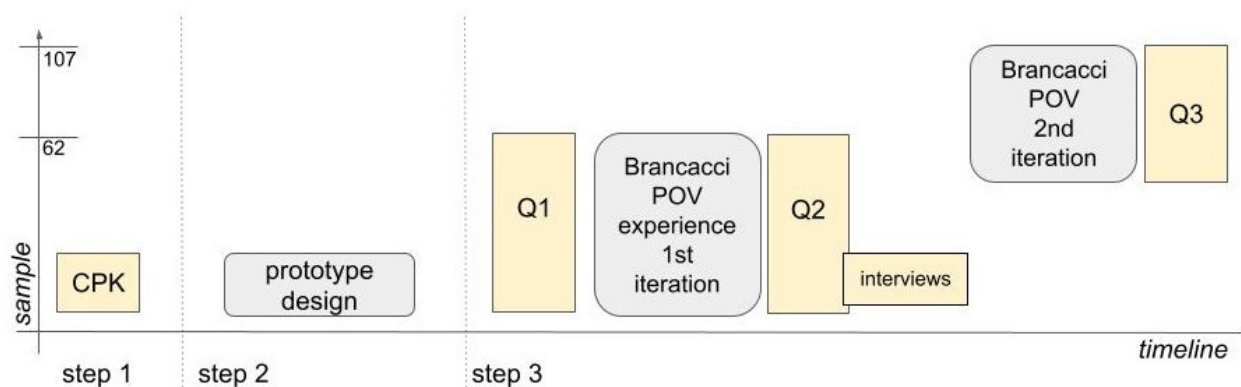
Figure 2. Adopted methodology overview, with an indication of the project timeline and number of participants involved in the exploration and evaluation process.

The first part of the research involved the creation of the CPK to better explore SC in the context of cultural heritage and to investigate the most suitable design elements and measures in which it could be used [19]. The CPK was not designed to obtain quantitative data but to explore a complex concept such as SC in the personal lives of people and, specifically, in the context of cultural heritage. Moreover, the CPK was aimed at soliciting ideas for the design of the multimodal application (Section 4). Probes, in fact, were originally developed as means for designers to detect useful and rich information and opinions in specific contexts and in a non-intrusive way [23]. They typically include a small pack of items that are carefully designed to "provoke inspirational responses" [24]. The CPK created for this study was tested with a relatively small target audience group, which was taken as a reference in the development of the application. The group included 32 students of a master's course. The majority of participants were Italians aged between 23 and 24 years. Many had an academic background in the humanities.

The CPK consisted of informally structured booklets of 41 pages, including a diary and an activity notebook with tasks to be carried out before and after the diary, in some cases with a QR code linked to online material. The kit is published and fully available online [25]. The booklets' instructions specified that participants needed to accomplish the activities within 15 days. They were numbered to guarantee completely anonymous contributions. The participation was voluntary, and everyone was provided with a paper and digital version of the CPK. The entire booklet contained questions and activities.

The diary was meant to make participants reflect and report daily and for 7 days, particularly with regard to giving and receiving support and help (support), participating in groups or communities (participation) and feeling excluded from a group (exclusion). In the table below, we report the questions and explored concepts (Table 1).

Table 1. The questions included in the diary section of the CPK.

| Question	Concept Explored
D1. Did I ask for help today? To whom?	Support
D2. Did him/her actually give me support?	Support
D3. Did I help someone today? Whom did I help?	Support
D4. Was everyone in the group involved? Why?	Exclusion
D5 Did I feel part of a group? Which group?	Participation

In the activity notebook, most tasks were meant to be carried out before participants worked on the diary. The activity notebook included eight activities and other questions (Table 2), defined following the works of [8,10] with the goal of better exploring the concepts of acceptance, sense of belonging, trust, support and empathy.

Table 2. Activities and questions in the activity notebook.

Activity/Question	Concept Explored
A1.1. What kind of diversity/unicity do you think you have?	Acceptance of diversity
A1.2. Did you experience people not being accepted in groups?	Acceptance of diversity
A1.3. Which social group(s) do you think you belong to?	Sense of Belonging
A1.4. Which social group do you think you do NOT belong to?	Sense of Belonging
A1.5. Do you trust your university representative?	Trust
A2. Draw your support network	Solidarity and helpfulness
A3. Your groups	Groups Categories
A4. Empathy network task	Empathy
A5. Trust network yask	Trust in Institutions
A6 Community Task: During the day, talk with someone you don't usually talk to and add your thoughts/reflections	Social network, Behavioural change
A7 Support Task: During the day when you need help try to say: "Would you help me?"	Solidarity and helpfulness
A8 Draw your revised support network	Cohesiveness after Action and dialogue
A9 With whom you would share your personal stories?	Groups categories

Not all participants completed the entire CPK. Although the amount of feedback is not statistically relevant, the result offered indications on how to design for social cohesion.

Activity 1 (A1: Who-am-I) includes questions about diversity/unicity, experiences about people not accepted in groups, sense of belonging in groups and feeling of trust on institutions. Activity 2 (A2: Support network) requires participants to think about people and groups around them and place them closer or far away from them and drawing a stronger or wicker relation (continuous or dotted arrows) based on how much they feel to be supported/helped or support/help them (Figure 3).
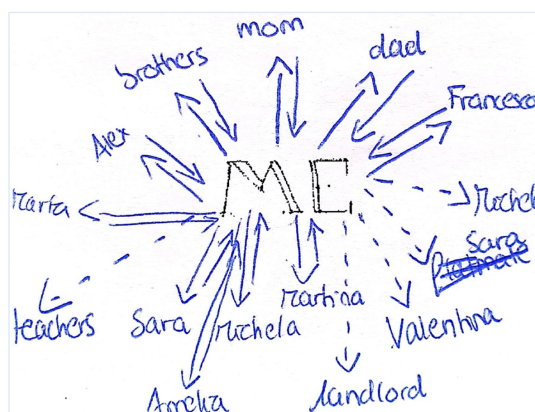
Figure 3. A page from the activity book with a support network (source: own research).

To be able to identify social groups relevant for our target audience, in the following task (A3: Your groups), we asked participants to associate the names previously included in the support network to a social group, inviting them to choose among seven pre-defined main categories, but leaving the last one open to other inputs.

The empathy network and trust network tasks (A4–A5) were meant to further explore the connection between support and empathy, empathy and institutions, and support and trust, taking into consideration cultural, social and political institutions. After the drawing activities, we included two tasks in which participants were asked to act during the day in non-ordinary ways. In A6 (community task) we asked participants to talk to someone they were not used to chatting with and to report their thoughts; in this way, we explored strategies to engage with people potentially distant or of a different social group [26] and reaction. In A7 (support task) we triggered the request of help and asked participants to introduce, in their requests, specific sentences to increase awareness and motivate behavioural changes [26].

The last tasks were included at the end of the CPK, since they were meant to be carried out after filling the diary (A8). Here, the participants were asked to again draw their support network (A8) and compare it with A2, with the purpose of reflecting on social cohesion and to understand if, after the tasks that required actions and dialogue, distant or weaker connections were modified. Finally, they were asked to specify with whom they would have accepted to share their personal stories (A9) with the goal of understanding a sense of belonging to specific social groups.

The second step required the discussion of CPK findings with the team of designers and developers, and to transform them into design elements and strategies to immediately use in the creation of a multimodal prototype (the Brancacci POV). We planned to build the prototype in an iterative way to evaluate SC aspects in different conditions [22] and to specifically verify if the included components could minimise and improve the distance between cultural institutions and citizens. The first prototype explored hybrid collaborative guided modalities, with participants invited to attend physically together to a virtual tour of a monument. A second prototype, currently under development, focuses on the same tour but is fully remote.

The third step of the methodology was aimed to evaluate the prototype without defining a-priori specific hypothesis, but exploring visitors' experience of the Brancacci POV and their perceived effects on SC, with a focus on the level of participation of each member (in-group contact), the perception of distance from social groups belonging to out-group contacts, the impact of the experience on participation and the connectedness with others.

To this end, a visitors' survey was designed and conducted through a structured questionnaire to be administered to visitors participating in the Brancacci POV experience. Visitors' perceptions and experiences were measured using items rated on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree), which were adapted from previous studies [8,10,26,27]. The exploratory approach also included post-experience interviews to visitors, which were aimed to get an in-depth understanding of specific aspects that emerged during the hybrid experience.

The survey and interviews were carried out in Florence, Italy during two different events where the Brancacci POV experience was presented to the public and tested. The first was a public event dedicated to cultural tourism, i.e., the TourismA fair (September 2022). The second was an event reserved for experts in the field of conservation science, i.e., the ERIHS launch event (October 2022).

Visitors were invited to participate to the Brancacci POV experience and to the survey on a voluntary basis, after having signed an informed consensus. They were asked to complete an anonymous questionnaire (Q1) before the experience. Q1 included questions on prior knowledge about the Chapel, frequency of visiting cultural heritage sites, feelings towards SC and personal information. The sessions were audio recorded to capture the verbal interactions among participants during the experience. Immediately after the Bran-

cacci POV sessions, a second questionnaire about participation and inclusion dimensions was administered (Q2). Afterwards, users were invited to participate in a semi-structured interview about how they experienced some aspects of SC. Q1 and Q2 required participants to reply to similar questions, whose goal was to verify if conditions were changing before and after the experience (Table 3).

Table 3. Comparison between pre (Q1) and post (Q2) experience inquiries.

Q1	Q2
A. From whom do you feel to be more distant or less close to?	5. After the experience, from whom do you feel to be less distant or closer to?
B. In the creation of the groups for the Brancacci POV experience, with whom would you NOT to be in the group with?	4. With whom did you take part in the experience and with whom would you like to repeat the experience with, if you could?

To verify if the design elements included in the Brancacci POV were successfully developing or strengthening cohesiveness, we have compared two of the questions in the pre and post experience (Table 3).

The questions Q1-A and Q2-5 are intended to investigate the perceived distance of the participants from specific and previously defined social groups (namely employees of cultural institutions, conservators, researchers, professors, and museum professionals).

During the presentation of the Brancacci POV at the second event, we decided to reduce the effort and time needed by visitors to complete all questionnaires and interviews. Therefore, we prepared a unique version (Q3), merging Q1 and Q2. Q3 was made of 35 questions and divided into 5 parts to be completed after the experience. We report here only the questions specifically related to SC in Q3:

1. With whom have you taken part in the experience?
2. Which character did you choose?
3. How was the impact of the collaborative experience? Explain how you agree/disagree with the following assertions:

    a. I would like to spend (more) time with the persons I have made the experience with
    b. I felt to be part of the group
    c. I felt more connected to the others

4. With whom you would like to repeat the experience if you could?

    a. The same group
    b. With friends
    c. With colleagues
    d. With my family
    e. Others

5. After the experience, from whom do you feel to be less distant or closer to?

    a. Museum institution
    b. Cultural Institutions
    c. Professional restorers
    d. Professors or academics
    e. Researchers
    f. Students
    g. Others

Table 4 reports the characteristics of visitors who participated to the survey ($n = 107$), including those who participated in the Brancacci POV either at TourismA ($n = 62$) or at Manifattura Tabacchi ($n = 45$).

Table 4. Summary of the characteristics of visitors participating to the survey.

Sample Characteristics	Frequency	Percentage
Age (in years)		
<18	6.00	6%
19–26	11.00	10%
27–36	13.00	12%
37–46	18.00	17%
47–56	27.00	25%
57–65	21.00	20%
>66	11.00	10%
Nationality		
Italian	87.00	82%
International	20.00	18%
Occupation		
Intellectual, scientific or highly specialised profession	49.00	47%
Student	17.00	16%
Technical profession	12.00	11%
Retired	11.00	10%
Other	9.00	8%
Office work	8.00	7%
Commercial activities and services	1.00	1%
Physically visited cultural sites (during last year)		
>6 times	54.00	51%
3–5 times	31.00	28%
1 or 2 times	21.00	20%
Never	1.00	1%
Virtually visited cultural sites (during last year)		
>6 times	8.00	7%
3–5 times	13.00	12%
1 or 2 times	36.00	34%
Never	50.00	47%

We also used the qualitative feedback from interviews ($n = 13$) and results from the analysis of group behaviour during the collaborative task to determine the perception of cohesiveness and the Brancacci POV most successful design features in the participants' opinion. The analysis of observations and group sessions focused on the following dimensions: the presence: the presence of personal and intimate thoughts during sharing tasks ("why did you choose exactly that character?"); the presence of group laughter or other indications of emotions as building elements of relationship between peers [28] or the presence of exchanges.

4. Results

4.1. Exploring SC through Cultural Probe Kits

Findings are discussed in this chapter, from the perspective of the explored concepts: exclusion; participation; acceptance of diversity; sense of belonging and identification of social group categories; trust and support/solidarity; and helpfulness.

4.1.1. Exclusion and Participation (D4, D5)

In the diary, we noticed that most of the participants reported to feeling very involved, during the day, especially during group activity with friends or family; most of them declared that during the activity, every member of the group was involved; a majority wrote to have not felt excluded during the day. Those who reported to feeling excluded reported that this was caused by not having received explicit invitations to activities or

to have felt not involved in discussions. Strong cohesion is felt only with social groups to which the participants already belong.

4.1.2. Acceptance of Diversity (A1.1, A1.2)

In A1.1, half of the answers identify as main unique characteristics the cultural and social background, the origins and religion, while in A1.2 most of participants reported they experienced at least someone not being accepted in a group they belong to (in-group).

4.1.3. Sense of Belonging and Identification of Social Group Categories (A1.3, A1.4, A3, A9)

In the two open questions about the affinity to specific social groups, in A1.3 we noticed that mostly mentioned in-groups were as follows: classmates, friends and family, with sub-groups connected to specific activities carried out by the group (as people/friends with whom they use to spend time together for music, leisure, culture, creativity or they work with) or based on the physical location (people living nearby: "citizens", "roommates"). On the other side, in A1.4, participants mostly reported to not belong to groups of "people with different personalities, interests, mental structures" and "people with different political, religious thoughts", demonstrating a multifaceted classification of these groups, whose main characteristics is "diversity". To better explore the affinity with specific in-groups' categories and find out which social groups participants felt most connected with and trusted most, we also used A9, in which the majority reported they would have shared their personal stories with "best friends", "family" and "classmates" but also with "teachers or university coordinators", showing a stronger connection with this group (Figure 4). Nevertheless, as expected, the general tendency is to accept to share with people belonging to the in-group circle.

**Figure 4.** Word cloud (source: own research, made with Voyant Tools [29]) of A9 task.

4.1.4. Trust (A1.5, A5)

In the exploration about distance/trust with institutions (A1.5), the majority reported to have a middle/high level of trust in the university representatives, demonstrating that this type of institution is perceived quite close to the "student" group. A5 confirms this closeness and highlights how cultural institutions are felt distant from the participants or absolutely absent from their daily life.

4.1.5. Support/Solidarity and Helpfulness (D1, D2, D3, A2, A6, A7, A8)

In the diary, questions on support received equally positive and negative replies. Moreover, we also noticed that the majority tends not to ask for help in daily life. In the comparison between A2 and A8, during the support network activities, we noticed how half of the participants reported that the tasks made them reflect on the following: the quality of help and support; who were most important people in their network; the high

number of daily interactions and their importance; how much one is helped or helps others; the presence of more interlinks than expected. This appears also in the comparison between the networks A2 and A8, where in most of A8 networks there is a change with less people, new bonds, stronger edges and/or weaker arrows. It is significant that the majority of the participants learned something useful from the task, thus further demonstrating how these types of tasks produce self-reflection. Moreover, from the comparison among the number of nodes (In the network, the nodes represent the actors (the dots on the graph); the edges represent the relationships between the actors (the lines on the graph)). drawn in all networks (Figure 5), it emerged that all networks produced after the first (A2) have less nodes and that participants have obtained a higher level of awareness on the value, strength, importance of some relations, and in some cases unexpectedly. In the cases of A4 and A5, the nodes were even fewer, showing how empathy and trust are exchanged with a very small circle of known people. This is also reflected in the diary activities (i.e., "I realised that I have more interactions with people I didn't think they were so important").
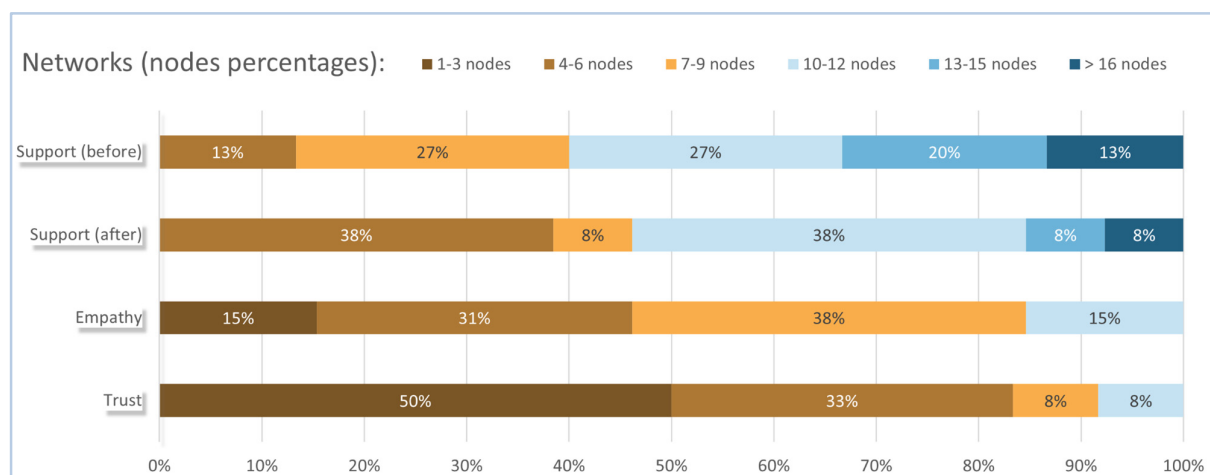
Figure 5. Comparison among number of nodes drawn in the networks of A2, A8 and A4 (source: own research).

A further element emerged in A6. Here, it was clearly shown that it was unusual to talk with someone to whom the participants did not usually interact with (out-group). Nevertheless, the majority of them reported a positive impression, discovering new aspects or unexpected dialogues. A7 also suggests that a guided task that solicits the request of help could trigger action toward others, contributing to a better cohesiveness, although a certain number also declared that it was not changing anything.

4.1.6. Findings

What was learnt from this exploratory analysis, includes a number of design elements and measures for SC. We have identified four dimensions associated with SC that are relevant for digital heritage applications, and specifically the following: "sense of belonging or identification", "solidarity and helpfulness", "participation" and "trust in institutions" [8,10]. From D4-D5, we noticed how the involvement in group activities helps to make people feel included and increases a sense of participation to the community. To avoid exclusion, the interaction should be accompanied by explicit invitations or/and by a moderator who helps to minimise the sense of being left out of discussions. In A1, the high percentage of participants who reported to have witnessed situations of exclusion from a group demonstrates how designers should consider strategies to minimise it. Furthermore, from A1.3-1.4-A3-A9, it emerges how social group classifications, used in SC studies, do not necessarily represent the types of groups that users report to belong to or to not belong to. Our results demonstrate a multifaceted classification whose main characteristics is "diversity". From the CPK, we can summarise that "distant" groups are the ones made of

people with different religious thoughts, age (old/young), country (Italians/non-Italians), economic or social class (upper/lower classes) and political ideologies, but also, more generally, people with different ideas, attitudes and interests. In line with this, cultural institutions have been represented quite differently among users, and with weak connection (A5). This seems meaningful, especially if we consider the considered sample and its cultural background. We also noticed how users tend to avoid asking for help or talking to unknown or out-group people, thus showing the complexities and challenges of triggering SC in its "help" dimension. From A2-A8-A4-A5 comparisons, and from the reported reflections, we see how an explicit request to act extroverted, to ask for help and to talk with out-group people increased self-reflection and awareness on the quality of relations, in some cases producing a positive reflection that might lead to an increase of empathy and a behavioural change towards SC. Designers could therefore transform this finding into interactive tasks accompanied by specific narratives. Moreover, the finding from A6 and A7 suggest the potential of introducing in multimodal applications tasks requiring or prompting dialogue, even with people outside the usual range, especially if solicited by a request or "call to action", thus confirming the potential benefit of "mediated dialogue" and provocative question approaches [30]. Interaction between in-groups and out-groups is crucial and could be facilitated thanks to the inclusion of specific tasks. Furthermore, we noticed how co-presence in a physical space is crucial and needs to be considered in any design. Intimate face-to-face communication has been previously studied [31] and has proven to be particularly useful in strengthening individual motivations to stay and be part of a group, with intimate topics shared, provoked by questions, as revealed by Roussou et al. and the prototypes developed within the EMOTIVE European project [30].

Tasks that include prompts to act (asking help, giving help and reflecting on trust) are also key in the development of empathy. Moreover, the inclusion of requests to provide opinions and perspectives (perspective giving) to be shared within the group could contribute to SC. The question regarding who and how this call to action should be designed depends upon the type of digital experience; it might be left to a game mechanic or to a real person (such as a guide, a moderator or a master, as in role-playing games).

Specifically, the task of drawing a support network and reflecting on it and the people around proved very appropriate for increasing awareness with an impact on SC. A possible conceptual model and design strategy might include the invitation of users, e.g., drawing such networks or asking for help before, during and/or the end of an experience to allow for reflection on actions and consequences in the creation of new bonds. This could also be stressed by the storytelling of the digital experience, with narrative elements that could make one reflect on consequences. Tasks including requests for collaboration in certain activities during the digital experience have also been identified as keys.

It is important to involve in-groups and out-groups in mixed ways, particularly in the organisation of collaborative digital experiences and in the creation of visitor groups. The perceived distance from a certain group could be used by designers not only in organising mixed groups but also when including an external reliable perspective (perspective taking), such as in the case of an expert participating in the experience.

To conclude, we found that potentially useful tools to measure SC in the context of an interactive application are self-reflection, asking provocative questions, facilitating semi structured interviews, observing behaviours and analysing the words used during exchanges in groups.

5. SC Design: The Brancacci POV Prototype

In the second stage of this work, we transformed the findings into practical design elements used in the development of a multimodal VR experience for a cultural heritage context: the Brancacci Chapel in Florence. The goal of this experience was originally to provide visitors with an "authentic" tour of the monument [32,33].

5.1. The Brancacci Chapel

The Brancacci Chapel, which sits inside Santa Maria del Carmine church, is a masterpiece of the Renaissance in Florence, Italy. In the second half of the 15th century, it was owned by the Brancacci family, a wealthy family of merchants opposed to the Medici family. It was initially painted by Masaccio and Masolino da Panicale, who depicted the story of human salvation. After the death of Masaccio, when he was only 27, the Chapel remained unfinished until its eventual completion in 1480 by Filippino Lippi. In the 18th century, a fire destroyed most of the church and partially damaged paintings. Several restoration works have been carried out since then. In 2018, art conservators noticed some detachments of the pictorial layer and an alert was raised, thus commencing a monitoring campaign. During this campaign, led by CNR ISPC in cooperation with Opificio delle Pietre Dure and Florence Superintendence, 3D digital acquisitions of the monument and of its frescos were made. The acquired data enabled us to develop a 3D interactive simulation of the Chapel, with the purpose of developing an innovative VR experience for citizens and tourists, entitled the Brancacci POV (Point of View).

Although these frescos are clearly very fragile, there is a lack of awareness about it and about the importance of this monument, which is largely unknown by tourists and even citizens. Moreover, after an initial informal survey in which we interviewed and talked with some of the visitors of the monument, we noticed a certain distance between citizens and the cultural institution taking care of the monument.

5.2. The Brancacci POV

In the design of the Brancacci POV, we wanted to include design elements that could contribute to triggering SC, with a specific goal of obtaining a social impact and reducing the distance between citizens and cultural institutions [22]. The Brancacci POV was therefore designed as a multi-user hybrid virtual reality (VR) experience that enabled groups of five visitors to explore the chapel together while being guided by an expert. The experience includes immersive (iVR) and not immersive (VR) sessions. The application aimed to develop SC through co-presence, mediated dialogue and by soliciting the exchange of ideas and comments among participants.

In the Brancacci POV, visitors can take part in the experience using different devices at the same time, such as smartphones and tablets (Figure 6), Oculus HMD (Figure 7) or desktop computers. The developed prototype is a WebXR application based on the ATON open-source CNR ISPC framework that has already been used to develop a number of different VR applications for cultural heritage [34]. Thanks to Aton, it was possible to develop specific UX and UI dedicated to the different roles of this first prototype: (a) the guide, (b) the visitors-characters, (c) the visitors with VR headset and (d) the reference screen.

Figure 6. The guide (**left**) controlling the session with the control panel and triggering interpretation exchange in the group (**right**) during a Brancacci POV session (photo: CNR ISPC).

Figure 7. (**left**) A visitor selecting a character; (**right**) a visitor with the Oculus HMD during a session of a Brancacci POV.

5.2.1. The Guide

In the Brancacci POV, the "guide" leads the experience through a control panel that controls the narrative (i.e., providing an explanation of the monument and its story), the tasks and the point of views (POVs). The guide also talks with participants, prompts action (i.e., the tasks), offers provocative questions to solicit exchanges and assists participants when needed. The guide can check the status of each participant to verify when they fulfil an assignment. When a visitor does not complete a task, the guide helps by sharing the same position in the 3D space (POV), which is received by all participants on their respective devices, enabling all to observe the monument from the same viewpoint and perspective. This functionality works as a "share location" in the Google Maps application. Only when everybody has the same view does the guide proceed with their explanation. The guide serves as the narrator and moderator (i.e., providing mediated dialogue), soliciting action and sharing (participation), and inhabiting the role of the trusted expert (trust) who visitors can rely on when listening to stories. Each story is connected to a specific point of view (perspective taking). The POV approach, moreover, was thought to specifically limit distance and offer all participants, even if metaphorically, the same tools and perspectives.

5.2.2. The Visitors

The prototype was developed to involve up to five visitors at a time. This number was set as a limit to simplify the exchange and to keep the group small. At the beginning of the experience, participants must choose one of six characters (identification: Figure 6-left): Eva, St. Peter, the angel, the cripple, Piero del Pugliese or the nobleman. Then, they sit on an assigned chair designated as their selected character in a semicircle and in front of the guide, who appears on a projected screen (Figure 6). Participants use their devices to interactively explore the 3D representation of the monument and its frescos. When prompted, they search for specific details or solve mysteries (tasks), using the tools that appear on their screen and following the indications of the guide or of others in the group. They also talk to each other in certain key moments (perspective giving) (i.e., when the experience starts, the guide asks the reason why they chose their specific character).

5.2.3. The Visitor with HMD

At the end of the experience, the visitors are asked to change roles and become a restorer (perspective taking), entering the chapel with a ultraviolet lamp and verifying what they have just learned in the experience (Figure 7).

5.2.4. The Screen

A big projected screen is a common visual reference during the experience. Here, multimedia content, hints, status of the visitors and points of view can be seen by all participants simultaneously.

6. Measuring SC

In the next stage of this research, we conducted an iterative quantitative and qualitative analysis on the Brancacci POV prototype, using the identified evaluation methodology (i.e., surveys and interviews).

Analysis

In the study of the Brancacci POV experience, we gave a greater relevance to the analysis and the comparison between groups made of acquaintances and those of complete strangers, since these groups had a lower starting level of cohesion than members who previously knew each other and belonged to the same social group [35] (pp. 293–295).

Although in most cases people preferred repeating the experience with people they knew (89%), a percentage also reported to appreciate mixed group. Only 7% of those who participated with strangers declared they would like to participate again with the same group.

The perception of cohesion post-experience was analysed through the questions (3a,b,c). Participants mostly agreed to feeling part of the group (66%), while half of them reported feeling connected (52%) and nearly half said they would have liked to spend more time with other members (43%).

Regarding the perception of cohesiveness in groups of complete strangers (Figure 8), 74% of participants reported feeling included. The connection within the group was perceived by 55% of strangers. Predictably, people who participated with strangers mostly did not agree or were neutral vis-à-vis the willingness of spending more time with group members (48%: "neither agree or disagree"). This finding is relevant when considering the perception of cohesiveness in groups made only of acquaintances, with a majority who stated feeling part of the group during the experience (64%), and with half agreeing with the notion that they felt more connected with others (47%) and were willing to spend more time together (55%). Although these numbers may not seem satisfactory, the remaining percentage was not against the idea, but reported having a neutral opinion (48%) about getting to know others better.
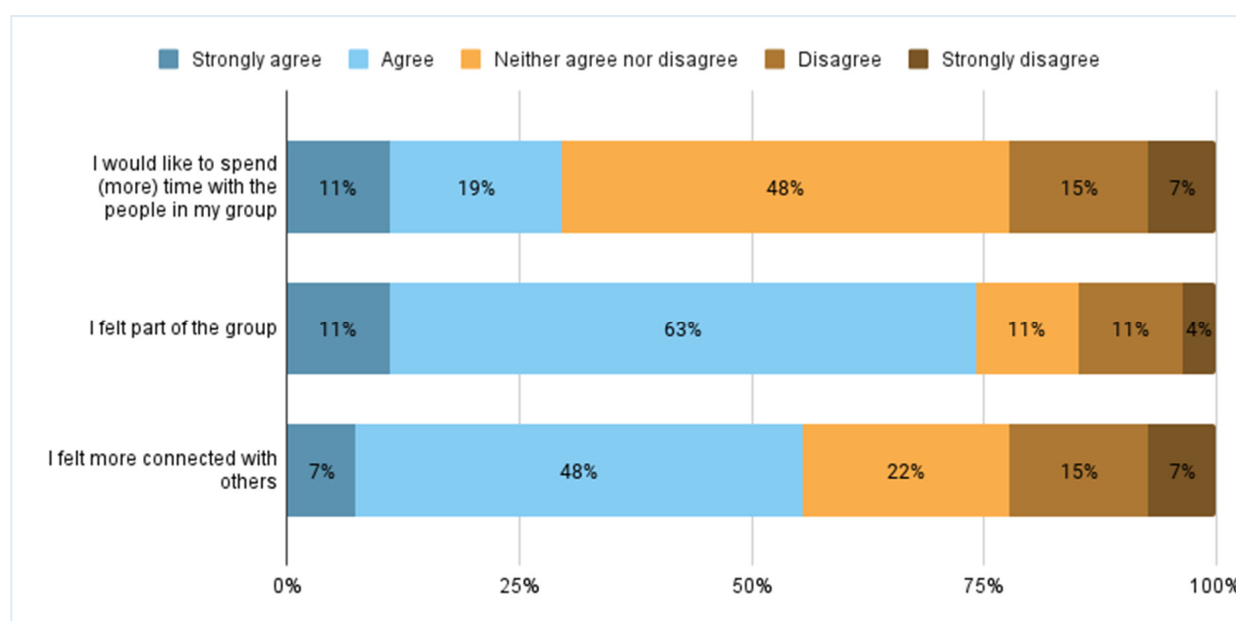

Figure 8. Perception of cohesion of groups made of strangers (source: own research).

Nevertheless, one of the most surprising results is that almost all those who had no previous experience with virtual visits reported perceiving cohesiveness while trying the Brancacci POV (81%).

Considering the overall results of the answers about inclusion, connection and the will to spend more time with the others, there is a vast majority of positive answers, especially on two statements: 65% or participants felt as if they were part of the group, and 45% reported feeling connected. These findings might confirm the positivity of collaborative digital heritage experiences as a way to enhance group cohesion.

The measurement of "distance" was analysed by comparing pre- and post-experience questions in Q1 and Q2. In Q1 (pre), most of the visitors declared feeling distant from professional restorers (33%) and museum/cultural institutions (29%), while in Q2 (post) the trend reversed, with participants giving positive feedback on feeling closer to the same group categories (Figure 9).
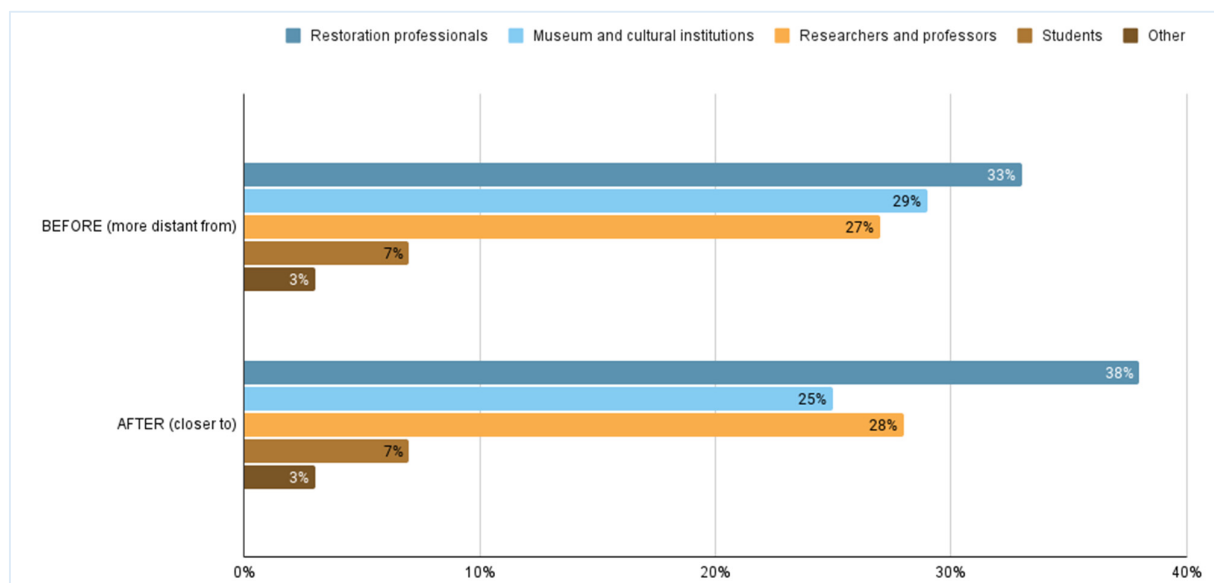
Figure 9. Perceived distance/closeness to institutions of groups comprised of strangers (source: own research).

Considering the terms used by the visitors in the interviews and in the session recordings, SC was perceived by half the participants (*n* = 13). The most significant words recorded included "building", "common", "create", "common", "together", "group", "share" and "near".

In the interviews, visitors suggested ideas on how to improve the Brancacci POV experience in order to make it more collaborative and to create greater cohesion among participants. For example, the presence of noise in nearby areas was considered an important obstacle when listening not only to others' comments but also to the guide's explanations and the videos' of restorers at work, which was projected on the main screen during one of the tasks. A quieter and more intimate environment was suggested as more appropriate. Additionally, some proposed the inclusion of more collaborative tasks or to extend the experience over several days.

Another suggestion regarded the selection of the character. Out of 76 people who shared with the group the reason why they chose a specific character, only 12% were guided by personal reasons (e.g., for a resemblance to their first name, for its physical/aesthetical aspect, for a memory), while most of them reported to have chosen by chance. The reason might be twofold. On the one hand, users were not concentrating on the action; on the other, they were not prepared to share their choice and those less accustomed to talking about themselves or simply reserved people might not want to open up to the group. This also seems proven by the act of "nervous laughter" heard in the recordings [28] (p. 3). Conversely, "group laughter" [35] (pp. 293–295) [28] (p. 3), which was also identified in the recording, was synonymous with tension relief, relaxation and leisure, serving as an indicator of agreement and cohesion between the various group members.

7. Triggering SC through Hybrid Experiences

In the final stage of the research, we analysed the findings on the visitors' survey, identifying the most successful and missing design elements. We also better verified the main factors that potentially create or reinforce SC in the context of interactive digital applications for cultural heritage. Factors impacting social cohesion are listed as follows:

- interaction between in-group and out-group;
- development of hybrid experiences;
- (external) call for action and reflection; and
- oriented storytelling.

Table 5 below reports how the design could pragmatically make use of these factors.

Table 5. Design factors and elements that could reinforce SC.

Design Factors	Design Elements
Interaction between in-groups and out-groups	1a. creation of mixed groups 1b. participation in interactive tasks 1b. mediated dialogue 1c. collaboration 1d. perspective giving 1e. multiple sessions
Hybrid experiences (digital/physical)	2a. co-presence in a physical space 2b. co-presence reinforced by embodiment in virtual space 2d. real-time human interaction (human guide or moderator) 2e. safe and quite environment dedicated to the hybrid experience 2f. intimate face-to-face communication
External call for action and reflection	3a. perspective taking (expert strengthening trust in institutions) 3b. help-oriented task (ask for help, give help) 3c. trust-oriented task 3d. draw network
Oriented storytelling	4a. provocative questions 4b. stories that make reflect on consequences. 4c. SC role playing

The discussion and sharing of tasks (Table 5: 1d, 1b) proved to be effective in favouring cohesion among group members, especially when everyone actively performed by speaking in front of the others [8] (p. 247) and when reflecting together.

The physical space in which the experience takes place has an impact on SC (Table 5: 2e). The use of a calm environment appears to be a requirement because distractions can be avoided. It is also important to provide a safe place in which participants feel at ease in the moment of sharing.

A potential improvement to be considered is to design experiences that could take place in several sessions (Table 5: 1e), such as in the case of role-playing game sessions, thus ensuring a continuity that could strengthen or improve connections and build cohesion with strangers.

Another impending improvement could include the introduction of formal and informal roles (Table 5: 4c), which could be designed to enhance cohesiveness. Choosing a specific role in a group, in fact, could strengthen motivation. When this motivation is shared, the group finds itself more cohesive and determined to achieve its goal [36].

The guide, moderator or master is crucial (Table 5: 1b, 2d, 3a), as are people in management roles who support singles.

Collaborative digital heritage applications could also be designed with tasks oriented to sub-groups (i.e., couples of players, small groups of students in a class, or of people in a team) as ways to explore reciprocal trust (Table 5: 3c), as in the "We Were Here" videogame cooperative escape game saga [37].

A summary of main design strategies is reported in Figure 10.
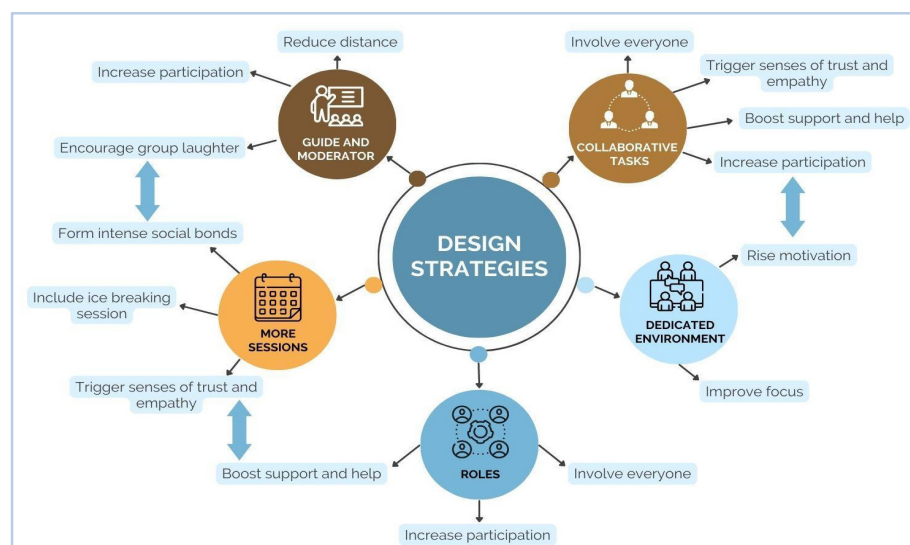
Figure 10. Key concepts with main design elements (from own research derived by interviews and surveys' analysis).

8. Conclusions and Future Research

In conclusion, digital interactive multiuser collaborative experiences, such as the Brancacci POV, could positively affect group cohesion regarding civic participation and the perception of distance from specific social groups.

The CPKs and combination of different data collection procedures—i.e., questionnaires with closed, open and multiple questions; observation of behavioural aspects and semi-structured interviews—provided useful insights for assessing SC in digital heritage experiences. Moreover, the results of the qualitative research could become the basis for future quantitative research.

The main assessment tools we found useful to study social cohesion are listed below.

1. Self-reflecting questions
2. Provocative questions
3. Semi-structured interviews
4. Behavioural observation
5. Analysis of words used during verbal exchanges/interviews
6. Emotion detection (laughter)

Although the present study did not adopt advanced automatic tools, the presented results suggest that including them in the application features could capture the presence/absence of specific sounds, words or behaviours (verbal exchanges), which could pave a way to improved responses and personalised prototypes.

In the future, we are interested to further investigate cohesiveness, including in the interviews, questions such as: "With whom would you NOT really want to participate?", inspired by "Participation and performance" [8] and "Acceptance of diversity" [10]; "With whom would you repeat the experience if you could?", as for "Relationships and Ties" [8] and for "Social networks" [10]; "Did cohesiveness occur? When?", "What could foster Social Cohesion?"; "I felt more connected with others", "I felt part of the group", "I would like to spend (more) time with the people in my group" (adapted from Kolar and Čater Likert-scale questions, [27]); "Whom do you feel most distant from?", "After the experience, whom do you feel to be closer to you and less distant?", "Who would you NOT really want to share your experience with?" (all were inspired by questions included in the cultural probe kit).

On the other hand, we noticed that the use of evaluation questions, such as "how often do you feel excluded in a group?", are not recommended unless formulated taking into account a peculiar situation in which the visitor might have felt excluded in the past

and perhaps investigate the reason why (i.e., "did you ever felt excluded during a cultural heritage experience? Why?").

Another lesson learned is that SC is better fostered when digital collaborative experiences are designed to improve users' knowledge on the work, commitment and possible issues that cultural institutions, professionals and experts face during their job. When this design objective is met, the results demonstrate a rapprochement with diverse social groups perceived as distant before the experience. After the experience, in fact, most visitors reported feeling closer to the specific social groups that were previously perceived as distant. Despite these promising results, we should clarify that when asking about "distance", we found it essential to avoid misunderstanding, including a definition of "distance from a social group", or to directly invite participants to give their own definition in order together unbiased data.

The results of cohesiveness for those not used to virtual experiences highlight how technology may not be a reason for division but rather for cohesion. This conclusion is particularly true considering the type of the set-up created for the Brancacci POV, with participants sitting in a circle and receiving/giving help to their "seat neighbour", thus contributing to solving small and big issues that might have emerged during the interaction with the 3D model, or the fulfilling of tasks.

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