arts

MDPI

Article

How to Enhance Perception of Reassembled but Incomplete Works of Ancient Art? Eye-Tracking Study of Virtual Anastylosis

Marta Rusnak *, Aleksandra Brzozowska-Jawornicka and Zofia Koszewicz

Faculty of Architecture, Wrocław University of Science and Technology, 50-317 Wrocław, Poland
* Correspondence: marta.rusnak@pwr.edu.pl

Abstract: In 1964 the Venice Charter described anastylosis as the only acceptable method of reassembly of architectural remains. Although the scientific community has agreed with the Charter's decision, many questions pertaining to the technical and aesthetic aspects of anastylosis remain unanswered. Virtual anastylosis seems one of the most promising digital solutions to finding at least some answers, as it permits testing various solutions before carrying out the actual physical re-erection of a damaged monument. Studying such variants with eye-trackers allows the participation of non-professional viewers at the very beginning of the process, that is at the design stage. By understanding how ordinary people look at different reconstructions, professionals and scholars can determine which elements would assist and which would hinder the instinctive assessment of the object's value and history. This study compares perceptions of three variants of the same column. A total of 232 people were divided into three groups and asked to examine different types of anastyloses: with an empty cavity, with a cavity filled with a brighter stone, and with a cavity filled with a stone of the same color and texture as the rest of the column. Their perception of the columns was then analyzed using several parameters, including the number of fixations, the time spent looking at individual elements, and the chronological order in which the parts of the stimuli was taken in. This paper explores the benefits and the potential of this new research tool as well as offers a more detailed look at what a viewer-friendly model of anastylosis may be like.

Keywords: anastylosis; eye-tracking; heritage; museum exhibition; perception; conservation; restoration

check for updates

Citation: Rusnak, Marta, Aleksandra Brzozowska-Jawornicka, and Zofia Koszewicz. 2023. How to Enhance Perception of Reassembled but Incomplete Works of Ancient Art? Eye-Tracking Study of Virtual Anastylosis. *Arts* 12: 15. https://doi.org/10.3390/arts12010015

Received: 28 October 2022
Revised: 15 December 2022
Accepted: 11 January 2023
Published: 16 January 2023

1. Introduction

The concept of anastylosis and its application in conservation and protection of architectural monuments at archaeological sites was described in article 15 of the Venice Charter: "All reconstruction work should however be ruled out a priori. Only anastylosis, that is to say, the reassembling of existing but dismembered parts can be permitted. The material used for integration should always be recognizable and its use should be the least that will ensure the conservation of a monument and the reinstatement of its form" (ICOMOS 1964). Since then, most of the scientific community involved in excavations has agreed that anastylosis is the only acceptable method of re-erection of architectural remains. The scientific discussion that has accompanied individual pieces of anastylosis focused primarily on technical issues, such as the minimum amount of original material necessary to perform anastylosis (ICOMOS 1964), the type of appropriate support structures for the original elements (Torun and Ercan 2013, p. 38; Vacharopoulou 2006, p. 78), and finally whether to fill the cavities or not, and if so, what material should be used for the filling (Torun and Ercan 2013, pp. 29, 37–38; Vacharopoulou 2006, p. 82). This last issue has been discussed in little detail, although it has been emphasized that the new inserts need to be visibly distinguished from the historic structure in a "slight, yet harmonious" way (Mertens 1984, p. 119; Petzet 2002, p. 190; Vacharopoulou 2006, p. 78), and that it is vital to ensure the mechanical and aesthetic compatibility between the old and the new fragments (Torun and Ercan 2013, p. 37).

The debate concerning how to fill in the cavities goes on, but in most cases it focuses on various technical aspects and advantages of different materials that can be applied for that purpose, for example how easily discernible they are from the original stone or how they age (Vacharopoulou 2006, pp. 82, 209–11, 260–1, 298). However, anastylosis is a design process, which requires not only technical, but also—or perhaps even more importantly—aesthetic decisions. Only a few researchers pay attention to the aesthetic and visual aspects of the contrast between the original elements and the new inserts (Mertens 1984, p. 119; Vacharopoulou 2006, p. 78; Bold et al. 2018). Many scholars accept the guidelines presented in the Venice Charter and claim that the new fragments should always be recognizable (Petzet 2004; Rusnak 2021a) or even "remain in the background" (Vacharopoulou 2006, p. 78) in order not to divert attention from the old parts. This, it seems, can only be achieved by means of a material which differs from the original one. Various methods of highlighting the new elements have been suggested and include differences in color, texture, or physical and chemical composition of the material, using stamps, labels or identifying marks placed on the new elements, and finally the application of modern technology and multimedia (Torun and Ercan 2013, p. 38; Vacharopoulou 2006, pp. 211, 260–1).

It is not only the visual distinction between the old and the new where cutting-edge technology comes in handy. Photogrammetry, 3D scanning, and other techniques of preparing digital spatial documentation make it possible to create, in a relatively short time, extremely accurate digital models of entire archaeological sites along with architectural monuments. As a result, virtual anastylosis can be fairly easily created (Agnello and Cannella 2013; Canciani et al. 2013; Kurdy et al. 2011; Stanco et al. 2017), which in turn makes it possible to test various solutions before an actual physical reassembly of a damaged monument is carried out.

It is understood that professionals involved in heritage management "should recognize their role as storytellers" (Hamilakis 2001, pp. 91–99) providing easy and clear access to what the past has to offer (Egloff 2019). Therefore, the final decision as to what kind of anastylosis to apply for the given monument remains with the experts responsible for this particular site and is therefore rather subjective. Since more and more people, including the members of the scientific community, seem to realize that this subjectivity may constitute a drawback, the voice of non-professionals has recently been gaining importance. The participation of such people in the process of making decisions concerning heritage has been postulated at least since the proclamation of the Burra Charter in 1979 (ICOMOS 2013; Sroczyńska 2021, p. 9), and then repeated and strongly emphasized in the 2008 Ename Charter (ICOMOS 2008; Sroczyńska 2021, p. 9). Research conducted among visitors of archaeological sites shows that they do consider anastylosis a proper method of protection of architectural monuments, but at the same time they express some doubts about "the monument looking fake" (Vacharopoulou 2006, pp. 221–6).

It should be strongly emphasized that anastylosis is a design process–by its nature individual and subjective, requiring many choices concerning technical and aesthetic aspects that may prove difficult to reconcile. The complexity of the process increases when the designers want and need to save materials, time, and/or money. Since it is our goal as specialists to facilitate the perception of what heritage has to offer (Sroczyńska 2018), we should perhaps ask ourselves if it is possible to formulate any clear rules, convincing arguments or objective methods that could support experts in their decision-making process. How to evaluate people's perception of anastylosis in its many variants? Believing that the management and interpretation of monuments "isn't magic" (Ham 2004) in this paper we are going to present a specific tool—the eye tracker—that in our opinion can facilitate discussions of experts, change the way we think about public participation in conservation, and develop our understanding of how heritage is perceived. The use of eye trackers can help build a bridge between virtual anastylosis and the actual actions that historical structures are subjected to in the conservation process.

1.1. Eye Trackers and Their Metrics

Eye trackers are devices most often used to diagnose the way people look at objects presented to them. There are many studies explaining how eye-trackers function (Duchowski 2007; Holmqvist et al. 2022; Poole and Ball 2006). This technology is not only used as a research tool, but it also enables the construction of medical aids (Fager et al. 2022) or makes it possible to control games with eyesight (Sundstedt 2012).

There are four main groups of eye-tracking devices. Stationary eye trackers enable an examination of how one perceives stimuli displayed on a screen (Plumhoff and Schirillo 2009). A mobile one, placed on the subject's head, makes it possible to collect data while the participant is moving in the analyzed space (Gholami et al. 2021). Eye trackers integrated with additional devices allow one to collect eye-tracking data in virtual reality simulations, and the last group does the same for augmented reality (Josephson and Myers 2019).

The way people perceive the presented objects is interpreted by analyzing fixations (points of one's focus) and saccades (quick shifts of one's gaze). The interpretation of fixations depends mostly on their duration (Galley et al. 2015) since cognitive fixations last from 150 to 900 ms. Saccades have a suppressive effect "when vision is drastically reduced" (Zimmermann 2020). As a result, only a few perceptual studies examine this aspect. Eye trackers record one's gaze path and make notes of fixations that fall within predetermined areas of interest (AOIs). The data obtained this way include:

- Visitors—the number of people who looked at a specific AOI;
- Revisitors—the number of people who looked at a specific AOI more than once;
- Average fixation duration (AFD)—the time when one's eyesight was fixed on the specific area;
- Time to first fixation (TFF)—the time that passed before a given area was visually explored for the first time;
- Average fixation count (AFC)—the number of fixations performed in a given area;
- Total visit duration (TVD)—entire time that subjects devoted to observing a particular AOI.

1.2. Eye Trackers, Architecture and Cultural Heritage

It is widely recognized that digital technologies can support, enhance, and supplement traditional conservation methods assets in architecture, archeology, and museology. Photogrammetry, videogrammetry, 3D scanning are generally used to digitize cultural heritage (Salleh and Bushroa 2022). For this reason, the potential of eye-trackers for heritage research should be assessed as very high. Scientists have extensive material that they can virtually modify, and the created variants of reconstructions/additions can be subjected to eye-tracking tests. This potential has not yet been exploited.

Eye tracking technology has been used to study people's visual reactions to cultural heritage. Researchers have examined how people look at paintings (Bailey-Ross et al. 2017), how people perceive heritage in media (Tzi-Dong Ng et al. 2022; Wu et al. 2019), how museum visitors behave (Reitstätter et al. 2020), and what encourages them to undertake cultural tourism (Rainoldi and Jooss 2020). Measurements based on eye-tracking data have been made in relation to landscape (Huang and Pan 2021; Qiu et al. 2020), urban layouts (Hollander et al. 2020; Krupina et al. 2017; Zvyagina and Assis 2018), elevations (De la Fuente Suárez 2020; Zou and Ergan 2019), historical interiors (Mandolesi et al. 2022; Rusnak and Ramus 2019) and historical details. There has been an interesting study that registered the gaze path during the process of knowledge acquisition in cultural heritage games (Raptis et al. 2019). An eye-tracking analysis has also been made of how various levels of luminance of cavity fillings affect the perceptions of anastylosis (Rusnak 2021b). The researchers decided to test their hypotheses in laboratory conditions, using stationary ET (Rusnak 2021a), but it is possible to test natural cognitive situations (Reitstätter et al. 2020), prepare experiments in VR (Zhang et al. 2019) and AR (Pedersen et al. 2010).

2. Research Goal

The accessibility of research tools enabling virtual reconstruction allows for something that was much less possible in the past—that is, to study the social reception of the considered variants. However, there are many factors that contribute to the perception of anastylosis and they cannot all be studied at the same time—to the contrary, they ought to be tackled one by one. Only then can one gain objective knowledge as to the connection between particular design decisions and reactions of viewers—knowledge that could later be translated into actual improvements in how exhibits are prepared so that their viewers can connect with heritage and history in the best way possible. In order to create an appealing tourist offer at archaeological sites and museums, designers need to add elements that the audience requires as well as remove potential obstacles (Elitaş 2021). That is why this research deals with one of such design decisions and people's reactions to it. The aim was to find out how different approaches to cavities in reassembled historical monuments affect the visual reactions of non-professional viewers.

However, this paper is by no means limited to a typical case study. The authors hope that new research experience gained while conducting this experiment as well as the conclusions arrived at will make it possible to further improve the methodology of conducting similar eye-tracking studies. Moreover, the article aims to promote the introduction of biometric tools, in particular the eye tracker, into the conservation process since the inclusion of such devices might allow experts to reduce the risk of making wrong choices.

Treating anastylosis as part of a broader issue of integrations in architectural restoration, the experiment would hopefully find a wider application. Specialists in the field have limited tools to evaluate the aesthetic aspect of their design choices prior to realization. The use of the eye-tracker and virtual images to analyze the way a general public observe artifacts can therefore make a valuable contribution to the topic. Frescoes, mosaics, sculptures, ceramics, architectural details, and even entire buildings could be subjected to research, without damaging them. This leads to sustainable heritage management that can result in measurable as well as financial benefits. Finally, it is intended as encouragement for other scholars, architects, conservators, and archeologists to use neurocognitive tools such as eye trackers to verify the methods and processes applied in the field of care and management of monuments (Coburn et al. 2017).

3. Materials and Measures

By describing the methodology, the authors are able to both justify the decisions that were made and ensure that the experiment may be repeated in the future (Holmqvist et al. 2022; Carter and Luke 2020). This part of the paper depicts the stimulus preparation process, describes the laboratory equipment, as well as outlines the characteristics of the participants and the criteria for initial data verification. It concludes with an outline of the research procedure, justifying subsequent decisions.

3.1. The Principle of Creating Stimuli

3.1.1. What Object to Choose for Research?

Objects of varied scale and made of multiple different materials are subjected to anastylosis. To focus on presenting a pro-social approach to management of monuments rather than an analysis of a very specific case, it was decided that the object used in the test should refer to the most common understanding of anastylosis. In the authors' opinion, if a non-professional was asked to select an image to illustrate the term anastylosis, they would choose a Greek temple, an ancient portico, or a stone column that has been reassembled. A Google search of the term anastylosis in numerous languages showed that this assumption was valid. It was then decided that an image of a reassembled limestone column would be used in the experiment.

In the future, we hope to conduct research on other objects that need restoration (sculptures and statuary complexes, frescoes, mosaics), but the comparative experiment required the selection of a formally and materially uniform object.

3.1.2. Preparation of the Stimuli

Reassembled heritage can be exhibited in a city (Fouseki 2009), at archaeological sites (Czerner 2015), or inside a museum (Fouseki 2008). These are three highly different cognitive situations and each is directly linked with a number of factors that may or may not influence the viewers' reactions to a particular object. Since the aim of the paper is to explore some general principles of how to optimize the presentation of anastylosis, it was viewed as beneficial to reduce the number of features that might affect the visual behavior of the experiment's participants. As the surrounding environment, landscape, and other architectural features were found to be visual distractors (Chelazzi et al. 2019), it was decided that the object would be displayed on a plain black background. This choice made it necessary to use 2D stimuli presented on a computer screen and in turn resulted in the use of a stationary eye tracker. The presented object was arranged vertically and made as large as possible to fit on a rotated screen. As a result of the enlargement, the accuracy of the data could be improved. Although such simplified presentation of the object makes the experiment less similar to a life-like cognitive situation, it compensates for that by making it possible to arrive at a much more precise interpretation, detached from broad scientific discussions about the influence of distractors on visual perception (Becker 2010; Irons and Leber 2016). We examine a series of interrelated stimuli, instead of one situation. Based on the results of an experiment conducted in 2022 (Rusnak 2022), we know there is a coincidence between 3D and 2D experiments sufficient to claim that the main relations between series of stimuli are preserved.

The basic model of a Ionic column prepared in Blender 2.65 is cracked but complete, without any cavities (Figure 1A). The other two visualizations differ in only one aspect. The first has an empty cavity (Figure 1B), and the second has a filling in the same place, but it is brighter than the original stone (Figure 1C).

Figure 1. Three types of anastylosis used in the experiment: (**A**) complete; (**B**) with an empty cavity; (**C**) with a cavity filled with lighter stone.

In order to choose the level of luminance for the filling in the third variant, a short preliminary experiment was conducted among 25 volunteers. These were students of the 1st or 3rd semester of MSc studies in Architecture and Monument Protection, at the Faculty of Architecture of the Wrocław University of Science and Technology. They constitute a homogenous group characterized by similar age, knowledge, and skills; they tend to understand conservation theory but can boast little practical experience which could affect their judgement. These students were presented with several variants of the same anastylosis modified in Photoshop Adobe Creative Cloud CC2015 so that their cavity fillings varied in luminance (Figure 2). They were asked to mark all options they considered inappropriate as well as the option they deemed most preferable. Table 1 summarizes the results.

Figure 2. Variants 1–8 presented to the participants of the preliminary experiment. Eight examples differ in the luminance of the additions..

Table 1. Answers given by the participants in the preliminary experiment.

		1	2	3	4	5	6	7	8
I	**Selected as the best option**	0	3	11	4	1	0	0	6
II	**Excluded as poor alternatives**	25	4	0	0	19	25	25	3
	Final note = I–II	−25	−1	11	4	−18	−25	−25	3

Since the third variant was the one that most participants opted for and no participants deemed inappropriate, it was chosen as the one used for the experiment.

3.2. Laboratory, Hardware, and Software

The laboratory was a quiet room with dimmable lights with a stand for the participant and for the supervisor. The researcher sat to the side, out of sight of the participant. All unnecessary equipment was removed from the room. Our goal was to present the prepared stimuli at as large a size as possible. It was therefore decided to turn the 24″ monitor vertically (DELL Ultra Sharp U2415b). Because significant vertical movements of the head and eyeballs negatively affected the quality of the collected data, after a trial run it was decided to keep a 10 cm distance between the edges of the screen and the edges of the column. Adjusted at the beginning of the data collecting process, the display settings—contrast, color, brightness—were not changed at any further point. According to the producer's guidelines, the participants sat at a distance of 70–90 cm from the screen (Tobii Pro Site 2022).

3.3. Participants

Efforts were made to ensure cultural, gender, and age diversity while maintaining methodological homogeneity within the group of volunteers attracted via posters, leaflets, and social media advertising. Potential candidates reported their willingness to participate online. We began with a questionnaire that collected basic data about the participant (gender, age, place of residence, whether they wear contact lenses or glasses, declaration of visual impairment). Our participants were all Polish adults (18) younger than 65. They lived in the Wrocław metropolitan area and declared that they did not have any vision problems (including color vision deviations) or that they compensated for these by wearing corrective glasses or contact lenses. There was no optometric verification of their statement. Because the expert viewpoint differs from the one of non-professionals (Darda and Cross 2022), no architects, musicologists, art historians, archaeologists, or students involved in these areas were accepted as participants. We invited 250 people to the research, but recorded 232 people (73 exposed to stimulus A, 81 to stimulus B, and 78 to stimulus C). A written consent was obtained from each of the participants. They were free to withdraw from the study at any time without providing a reason. Moreover, each volunteer received a voucher as a reward for participating in the experiment.

3.4. Procedure

We adapted the lab furniture to fit the individual needs of volunteers, and we began the experiment proper. The five-point calibration was accepted when the maximum error was smaller than 0.50° and the average error was not bigger than 0.30° (Carter and Luke 2020). Calibration is a process of adjusting the ET settings to the individual structure of the eye (Figure 3A,B). Only this allows for precise indication of where the participant is looking. Too long search for the right parameters can cause fatigue in the participant. Care should be taken both about the quality of the data and the comfort of the volunteers. If after three calibrations it was impossible to achieve desired values, the researcher tried to identify the obstacle in less than 3 min. If the two following attempts at calibration remained unsuccessful, the experiment was run so as not to disappoint the participant, but the collected data were not used in the calculations. Several other images and visualizations depicting anastyloses were also displayed. Separator boards with instructions were placed between the images (Figure 3). Each stimulus was displayed for ten seconds. The separate boards were displayed for three to five seconds. Participants were asked to "find and count new items"(Figure 3C). Owing to this predefined task, the cognitive intention was the same for all participants, which allows the data to be interpreted (Tatler et al. 2010). The answer was noted while the next board was displayed with a reminder of what the task was (Figure 3F). The purpose of the first five images was to inform the participants about the nature of the experiment without a straightforward explanation what anastylosis is and what the research entailed. Since it is best not to show the stimulus when participants are not yet familiar with the task, the stimulus A, B, or C was displayed randomly as 6th–12th image in the sequence. It was important for one observer not to see more than one of these three stimuli, as the use of the short-term memory could affect the data (Atkinson and Shiffrin 1971). The image presented as number 4 in the sequence had a cavity with no filling. This was intended to show to the participants that there might be no "new items" in the picture and thus prepare them for the possibility of there being no new additions in stimuli A and B.

At the end of the experiment, the volunteers answered questions of yet another questionnaire. Printouts of illustrations were shown to them. They had to specify which element of column (one they saw—A, B, or C) was, in their opinion, the most important one.

It is significant that the participants did not know the actual purpose of the research. It was not explained to them what anastylosis is. That is, because when visiting museums or archaeological sites, most people do not think about this aspect or must intuitively discover what anastylosis is.

The size of the research group decreased after the initial analysis. About 35 recordings were considered unreliable. The most common reasons for exclusion were external factors (e.g., the system crashed, someone entered the laboratory, the participant's cell phone rang). Some participants turned out to be unaware that they had strabismus. The calibration process failed for several participants. Finally, the data for two participants were inconclusive due to defects in registration caused by drooping eyelids or long eyelashes.

Ultimately, the analyzed research group included 197 people (A-63/B-70/C-64) (Figure 4); 116 women, 80 men, and one nonbinary person participated in the research (Figure 5).

Figure 3. The course of the experiment (as presented during the experiment-in Polish). (**A**,**B**) Calibration section. (**C**,**F**) Separator boards with instructions. (**D**,**G**) Illustrations/stimuli (displayed for 10 s). (**E**,**H**) Separator boards with instructions—when the volunteer answered, another board was displayed. (translation: (**A**) Please look at the point that will move on the next board. (**C**) On the details shown, within 10 s find and count newly added elements. (**E**,**H**) Tell us out loud how many new items there were. (**F**) Recount new items).

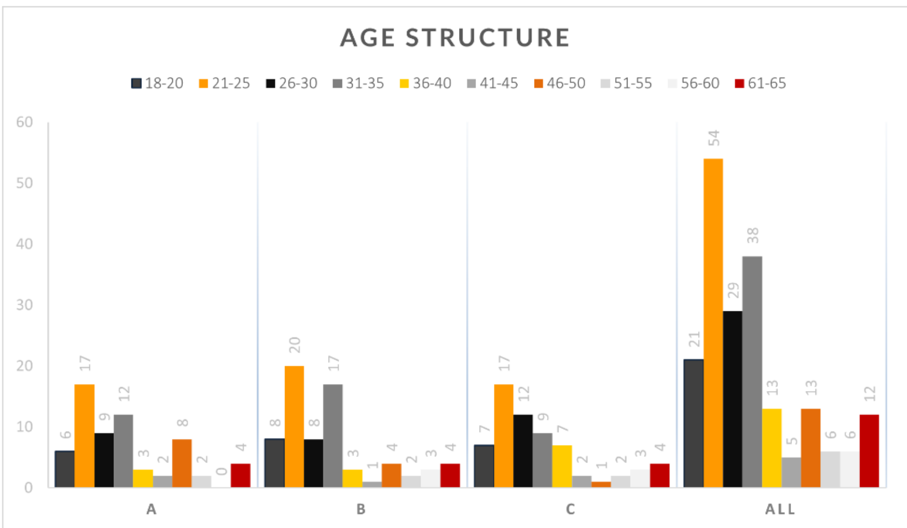

Figure 4. Age structure among participants.

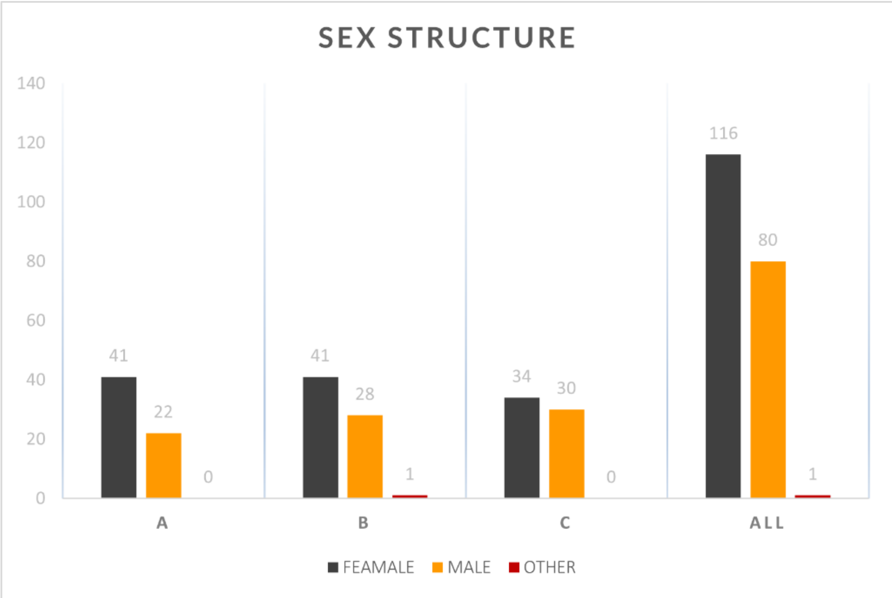

Figure 5. Sex distribution among participants.

In view of the research goals, the group was considered homogenous. Literature review shows that the number of participants in eye-tracking research varies from 10 to 259 (Savin et al. 2022; Cheng et al. 2022) and that the number of people exposed to a particular stimulus usually falls between 20 and 50 participants. Since each stimulus in the research under discussion was shown to at least 63 people, the group size should be treated as more than satisfactory.

4. Research Task

The guidelines which state that in properly done anastylosis the added elements should be clearly distinguishable from the original ones are one factor which will help analyze the three variants. It is, however, equally important to remember that any change done to historical monuments and pieces of cultural heritage should acknowledge their aesthetic dominants and keep them in focus of the viewer's attention. Since the column's capital is generally regarded its most important part, the most preferable variant of anastylosis will be the one that retains the capital as the main focal point. One additional characteristic which might prove important is the amount of attention paid by the viewers to the entire object, since cognitive engagement with a monument in its entirety is also seen as a strictly positive feature.

5. Results

5.1. Gaze Path Analysis

5.1.1. Division into Analytical Fields

To analyze the way people perceive an object, it is necessary to predetermine specific fields within the image. Each such field is called an area of interest (AOI) and fixations are grouped as falling within a given AOI. The same AOIs were established for all three stimuli (Figure 6). Each image shows the area that covers the entire capital—AOI TOP—and the triangular modified area—AOI NEW. The floor and the dark background correspond to AOI BLACK. Due to the accuracy chosen for the measurement and the accepted calibration result, the AOI range does not match the edge of the presented column. As a result, AOI TOP and AOI NEW were enlarged by 0.8 cm in each direction, to reduce the risk that the viewer's gaze at the given part of the column will not be counted as a fixation within the AOI for purely technical reasons. XLS data reports were generated for the indicated AOIs (additional file). Data were analyzed and one way ANOVA was used to determine the significance of deviations.

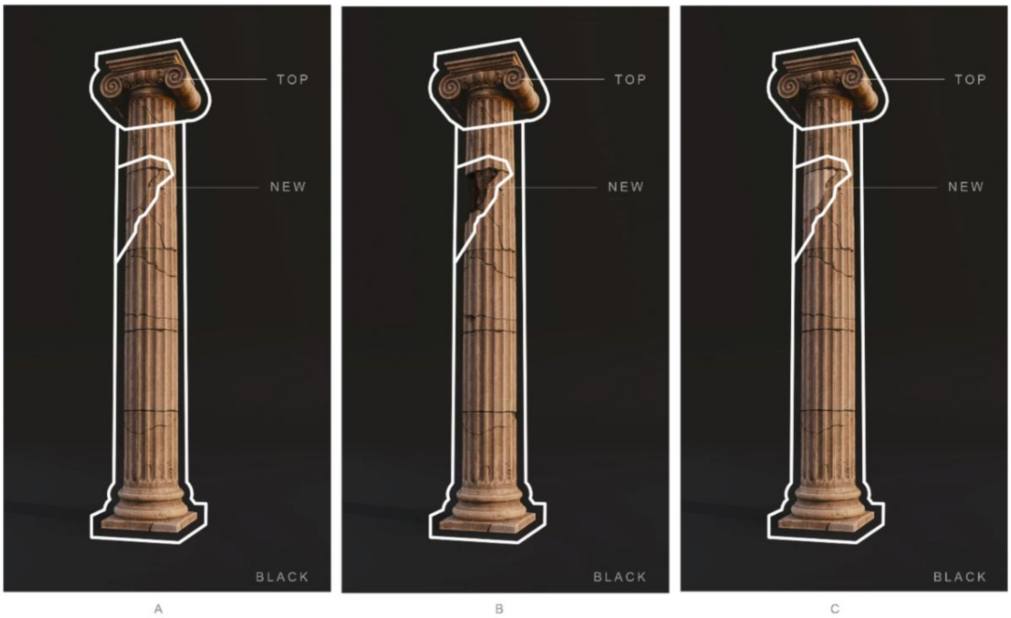

Figure 6. AOIs for stimuli (**A**–**C**).

5.1.2. Entire Image

The average fixation duration (AFD) calculated for the entire image was almost identical for all three stimuli: A = 0.189 s, B = 0.184 s, C = 0.181 s (ANOVA, $F_{(2,198)} = 0.952$, $p = 0.909$). Table 2 shows that the number of fixations performed on the entire image differed between stimuli A, B, and C (ANOVA, $F_{(2,198)} = 20.52$, $p = 0.00$). The data suggest that those exposed to stimulus B were the most active, whereas those who saw example C were the least active (Tables 2 and 3).

Table 2. Average fixation count (AFC) for four areas of interest.

Average Fixation Count (AFC)	Entire Image	AOI TOP	AOI NEW	AOI BLACK
example A	28.21 fix	14.46 fix	1.56 fix	1.23 fix
example B	29.36 fix	15.00 fix	6.51 fix	0.98 fix
example C	25.83 fix	15.50 fix	2.36 fix	1.09 fix
one way ANOVA	$F_{(2,198)} = 20.52$, $p = 0.00$	$F_{(2,198)} = 0.77$, $p = 0.46$	$F_{(2,198)} = 79.55$, $p = 0.00$	$F_{(2,198)} = 0.89$, $p = 0.62$

Table 3. Numbers of visitors and revisitors with average numbers of visits and revisits for AOI TOP and AOI NEW.

	AOI TOP				AOI NEW			
	Visitors	**Average Visits nr**	**Revisitors**	**Average Revisits**	**Visitors**	**Average Visits**	**Revisitors**	**Average Revisits nr**
example A	63	3.95	61	3.14	42	1.21	24	2.36
example B	70	4.10	69	3.16	70	3.16	65	3.32
example C	64	4.62	63	3.64	47	1.86	39	2.78

5.1.3. AOI TOP

Almost all differences observed for AOI TOP turned out to be statistically insignificant (it is when in ANOVA $p > 0.05$). The participants made an average of 14.46–15.5 fixations within this AOI (Table 2). The total visit duration lasted from 3.26–3.56 s. Only one parameter, the time to first fixation, emerged as important for discussion (ANOVA F(2.198) = 38.558, p = 0.00). The volunteers usually looked for the first time at this zone (TTFF) after 0.96 s while looking at stimulus A, after 1.40 s when exposed to stimulus B, and after 1.07 s when shown variant C. Fixations were registered within this AOI for all volunteers and only four participants chose not to give it more than one look (Table 4).

Table 4. Answers to the questionnaire. Participants were to choose the most important item within the image. They were allowed to choose more than one item.

	AOI TOP	AOI NEW	ANOTHER ELEMENT	I DON'T KNOW/UNDERSTAND
A 63 people	59 (93.7%)	-	3 * (4.8%)	1 (1.6%)
B 70 people	54 (77.1%)	7 (10%)	9 ** (12.9%)	6 (8.6%)
C 64 people	62 (96.9%)	2 (3.1%)	1 ** (1.6%)	3 (4.7%)

* (damage/cracks/holes) ** (damage/cracks).

5.1.4. AOI NEW

When interpreting the results, more attention should be paid to the AOI NEW, because all differences observed there proved statistically significant (one way ANOVA, $p < 0.05$). The number of visitors and revistiors of this AOI varied between the stimuli. All of those exposed to stimulus B performed an average of more than three visits in this AOI. Variant B is also distinguished by the number of revisitors and revisits (Table 3). Using Table 2 and Chart 1 it can be seen that the lack of filling caused the biggest deviation in terms of fixation count. The participants who looked at stimulus C on average performed 4.15 fewer fixations within the AOI NEW field than those who looked at B. As a result of the increase in fixation count, total visit duration changed from 0.26 s to 1.71 s (Chart 2). Time to first fixation (TFF) also differs a lot between the stimuli (Chart 3). The distribution of this variable is clearly more concentrated for stimuli C. The participants looking at variant B noticed the gap on average after 1.31 s, but not later than after 2.86 s. The participants looking at example C on average noticed the brighter cavity filling after 1.91 s. Two participants exposed to this stimulus only spotted the filling after as much as over 6 s (however, those results were marked as outlying).

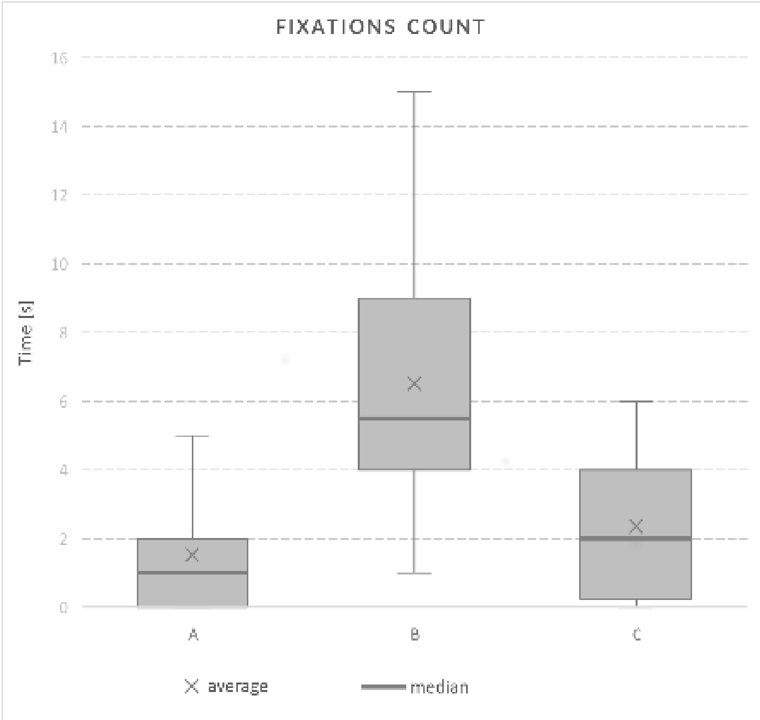

Chart 1. Fixation count (FC) AOI NEW.

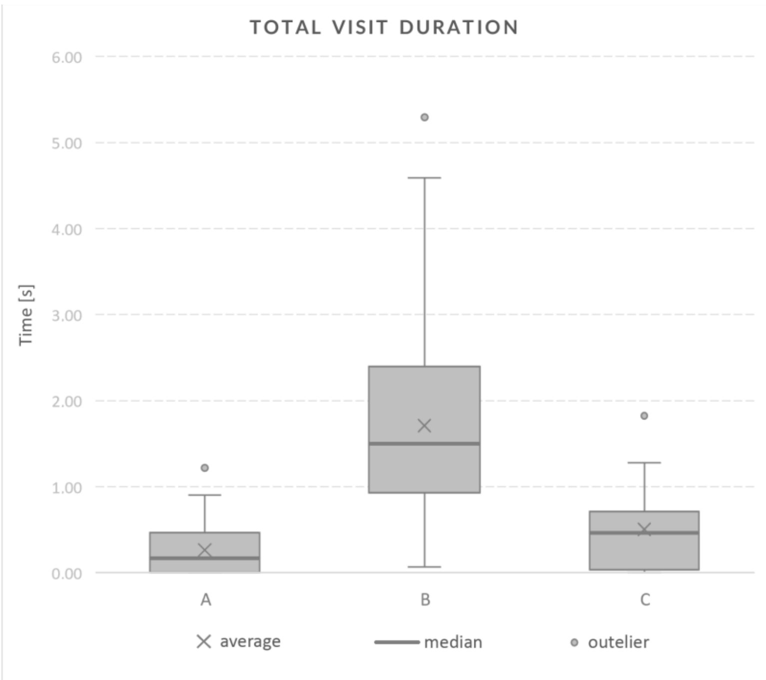

Chart 2. Total visit duration (TVD) AOI NEW.

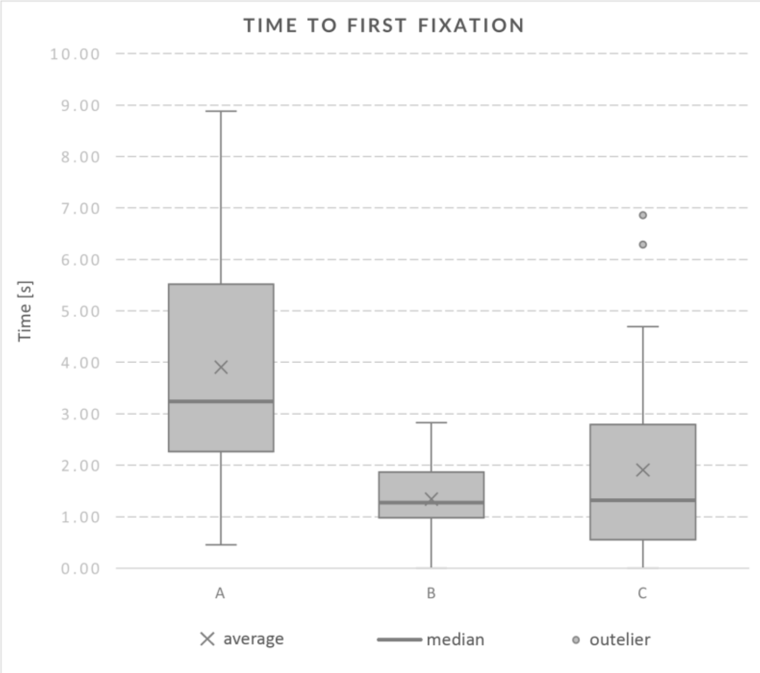

Chart 3. Time to first fixation (TTFF) AOI NEW.

5.2. Final Questionnaire

After the eye-tracker test, participants were shown one of the tested columns (the one they saw during the experiment). We asked the participants to identify the most important element of the presented detail. The results of the survey are presented in Table 4. The capital of the column was deemed the most important feature of stimuli A, B, and C by 174 (87.9%) participants. A total of 21 volunteers mentioned the cavities, cavity fillings, the fluting or the visible cracks as the visually dominant element. Some participants mentioned more than one item and there was a small percentage of volunteers who were unable to state which element was the most important.

6. Discussion

6.1. Interpretation of Results

When the visual parameters of the entire image are compared, it becomes evident that the smallest number of fixations was recorded for stimulus C. It is likely that this is due to the task given to the participants beforehand—they were able to easily find and count the new elements and therefore lost interest in the image after completing the task. Similarly, the fact that stimulus B provoked the largest number of fixations may have been caused by the lack of a new item, some participant may have continued looking for a less visible addition when actually there was none.

Fixation duration is usually regarded an important indicator of visual engagement (Nuthmann and Henderson 2010). Since little difference was recorded for this parameter, it may be assumed that the difficulty of the task was similar for all stimuli. The number of fixations recorded within the background or even off-screen is also another parameter that may be indicative of cognitive involvement. Some observers stopped looking at the column after completing the task which could be a sign of boredom. The analysis of AOI BLACK indicates that viewers were more or less equally drawn to the background, no matter which stimulus they were exposed to. The participants looking at examples A, B, and C performed a similar number of fixations in AOI BLACK (ANOVA $F(2,198) = 0.89$, $p = 0.62$). Total visit duration (TVD) for AOI BLACK was also not diverse (Figure 7).

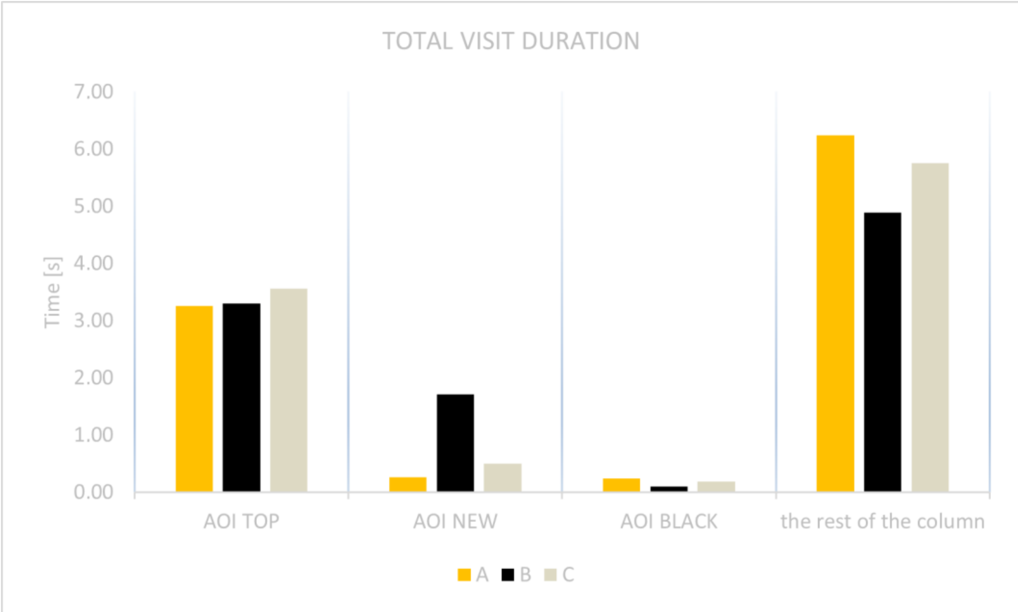

Figure 7. Comparison of total visit duration (TVD) for different AOIs.

The analysis of the way participants looked at AOI NEW clearly shows that the viewers looked at this part for the longest time when the cavity was left empty (Figure 7). If the entire time spent displaying a single stimuli is 10 s, an increase in the amount of TVD at a given area by 1.5 s should be considered significant. However, contrary to what the authors had anticipated, such a substantial change did not result in a decreased TVD for the AOI TOP. That means that the column's capital remained virtually as engaging in stimulus B as in the other two stimuli.

When viewing the empty cavity, the viewers made an average of 6.51 fixations, while only 2.36 fixations were recorded on average for the AOI with lighter cavity filling. It should be noted that 6.51 fixations represent almost half of what the viewers devoted to looking at the capital (AIO TOP). The area comparisons of AOI TOP (~56 cm^2) and AOI NEW (~21 cm^2) additionally emphasize this difference, showing how visually attractive the empty cavity proved to be for the participants.

The results of the final questionnaire show that the other parts of the column than those within AOI TOP and AOI NEW were similarly perceived by people exposed to stimuli A and C (Table 4). The empty cavity in stimulus B seems to have increased uncertainty among the participants. Around 25% of the volunteers were adversely affected by the cavity in variant B, which impacted their sense of what the most important part of the column is. Despite there being only one cavity, its size, shape, and location significantly altered the way non-professionals perceived this historical artifact.

The answers given by the volunteers in the questionnaire could suggest that the capital placed on a column with a large cavity would receive less visual attention than the one located on top the other two columns. However, the participants exposed to all three stimuli usually looked at the capital from 3 to 4 times (Table 3). The duration of time spent examining the capital and the number of fixations within this area remained virtually intact. The only noticeable difference could be seen in how quickly the participants paid attention to the capital. Graph 4 shows the average time after which the volunteers looked at the AOI TOP and AOI NEW fields for the first time. The participants exposed to variant B with an empty cavity on average took the longest to look at the capital. Moreover, the cavity in stimulus B attracted attention faster than the lighter filling in C. The graph clearly indicates that for people who saw stimulus B, there was a change in the order in which the parts of the column are noticed. The participants looking at column B usually first noticed the cavity and only then the capital, unlike the participants familiarizing themselves with the appearance of stimuli A and C, where the capital proved more important (Figure 8).

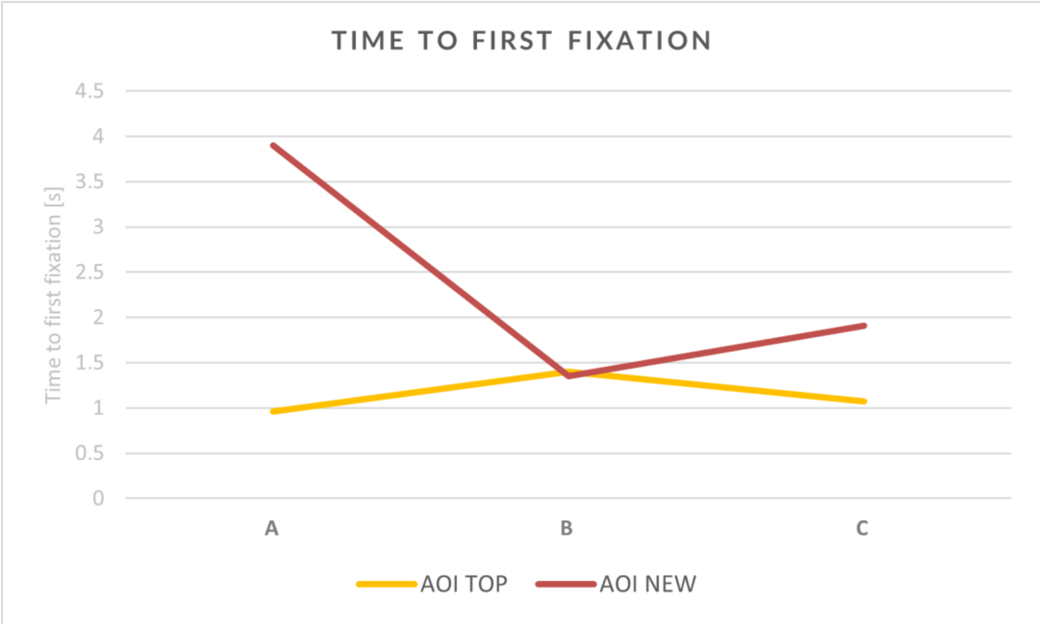

Figure 8. Time to first fixation (TTFF) comparison.

In our opinion, this alteration in the order of viewing was caused by significant irregularities. According to Gestalt theory, sight acts as a detector sensitive to difference (Gombrich 1984). Introduction of asymmetry in an otherwise symmetrical object proved more interesting than changing the luminance of the filling.

It appears that a successful anastylosis would be one that chooses a form that catches the eye and facilitates cognitive engagement in the viewers without drawing attention away from the original aesthetic dominant of the monument. This study demonstrates that adding new elements during the reassembly is more preferable than leaving an empty cavity. This is important because it tells an expert who wants to preserve the authenticity of historical buildings that leaving an empty cavity does not have to hinder the reception of the monument in its entirety. A case in which using a visibly different filling would make sense is perhaps when the designer wants to emphasize the contrast between the original elements and the damages caused as a result of some tragic incident, such as a terrorist attack (Jaramillo-Contreras 2012, p. 23), but this needs to be a consciously made decision aiming at a very specific effect.

The implementation of too bright additions, which are negatively evaluated by some experts (Bold and Pickard 2013, pp. 105–28) or decision to leave damages without an intervention constitute other aspects that should be taken into consideration while planning an anastylosis. Focus on emphasizing authenticity may cause that a monument subjected to an anastylosis will be perceived as a different object. Clearly, if one damage has this significant impact on the sense of sight, what will happen when many cavities appear? Conservators need to know that the aspect of perceiving traces of destruction (on any historical object they are taking care: mosaics, frescoes, statuary complexes, buildings . . .) may easily dominate the entire cognitive process. The restoration principle that claims that the intervention should not distract from the appreciation of the aesthetic quality of the artefact, but lack of intervention can do the same. A lack of intervention can be harmful both aesthetically and socially, making it more difficult for people to connect with their heritage. Furthermore, the lack of addition may represent a technological problem not extensively discussed in the article. A cavity may hinder the stabilization of an object. Perhaps such a change corresponds to the needs of monuments reassembled after terrorist attacks, where intangible value of an object can be evoked by traces of destruction.

6.2. General Remarks

The authors are aware that all the choices they made while preparing the stimuli-the abstract background, the selection of the frame, the lighting of the object, and the choice of the research tool influenced their findings (Foulsham et al. 2011; Gulhan et al. 2021; van Herpen et al. 2016). However, the fact that all these settings remained the same for stimuli A, B, and C made the comparison possible. It was obviously assumed that fields that generate interest in 2D generate similar or even greater interest in the same objects presented in 3D (Rusnak 2022). Consequently, in a real situation, the values observed for example B would be slightly mitigated. This is due to the lack of image framing and the ability to perform head movements (Haskins et al. 2020). However, the singularity of this element would be more eye-catching than the filling presented in example A.

Having analyzed all the data, the authors agreed that it is possible that due to the particular cavity visible in stimulus B, the entire object in this image may have appeared unstable to observers. At the time the experiment's methodology was being developed, this option had not been considered. It is possible that a more consistent outline of the object and an illumination coming from the opposite direction could lower the severity of the recorded deviations.

A mobile eye-tracker, in combination with real objects, could be used to conduct further tests. Such experiments may be difficult to conduct for a variety of reasons, and, just like the tests presented in this paper, may also raise numerous methodological issues. First of all, examining a real re-assembled monument and making additions to it could cause physical damage. The research would then have to be based on a copy of the object, which would be extremely expensive and resource-consuming. A study of this nature could be carried out within a museum, but should one desire to carry out such an experiment at an archaeological site, it would inevitably result in multiple complications. These challenges include changes in weather conditions (different intensities of light, changes in the color of the sky), people walking near the viewed object, and the inability to control the surrounding noise. Such tests, requiring considerable effort and time, would have to be conducted on a large sample to avoid the effects of so many variables affecting the results. That is why an eye tracker combined with VR may prove a more effective and realistic solution. However, this study shows that prior to preparing the spherical stimuli, several aspects of the eye-tracking tests conducted in VR environments must be dealt with, as there are some limitations, such as neck fatigue or dizziness caused by motion sickness (Mcgill et al. 2020; Mon-Williams et al. 1998). Moreover, one needs to bear in mind that even the best VR test, characterized by a high level of immersion, is not the same as reality. Several aspects need to be considered, including the fidelity of the presentation, e.g., the color (Gaiani et al. 2017), which has not been addressed in the current research (Zhang et al. 2019).

The research procedure applied in this study, did not allow a recording and an in-depth analysis of the participants' feelings. In the future, it may prove beneficial to identify the volunteers' emotions through recording their facial expressions (Filali et al. 2022).

7. Conclusions

As indicated in the introduction, the experiment focused on an extremely narrow section of the broad issue of anastylosis. A study of this type can only provide relatively general conclusions. We hope, however, that the doubts and problems described along the course of the experiment itself, combined with the acquired knowledge, will facilitate the development of further eye-tracking experiments concerning cultural heritage. Eye trackers are tools that show exceptional potential, if used properly by planners, archaeologists, conservators, architects, and museum curators.

They can bridge the gap between the virtual and the real, between hypothesis and actual physical measures. It appears that science would only benefit from an increased number and frequency of eye-tracking tests used for both case studies and verification of established scientific theories. To confront one's expert views and assumptions with the reactions of non-professionals requires courage and modesty, but at the same time yields incredible, otherwise inaccessible results. Experts do not need to be able to predict the reaction of ordinary observers (Rusnak 2021a), but they should be ready and open to accepting and using the conclusions resulting from public consultations and lay people's participation in decision-making processes concerning various heritage issues (Parowicz 2019). It seems that only then can a real pro-social and sustainable care of heritage that the ICOMOS Ename Charter (ICOMOS 2008) and Burros Charter (ICOMOS 2013) postulate become a reality.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/arts12010015/s1.

Author Contributions: Conceptualization, M.R.; methodology, M.R.; software, M.R. and Z.K.; validation, A.B.-J., M.R., Z.K., A.B.-J.; formal analysis, M.R. and Z.K.; investigation, M.R. and A.B.-J.; writing—original draft preparation, M.R. and A.B.-J.; writing—review and editing, M.R. and Z.K.; visualization, M.R. and Z.K.; supervision, M.R.; project administration, M.R.; funding acquisition, M.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received founding from National Science Center Poland 2021/05/X/ST8/00595.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, reported to the authorities of the Faculty of Architecture, and approved by WUST Ethics Committee.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are provided in Supplementary Materials.

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

References

Agnello, Fabrizio, and Mirco Cannella. 2013. Ruined Archeological Heritage. Survey, 3D Modeling, Virtual Anastylosis. *International Journal of Heritage in the Digital Era* 2: 419–31. [CrossRef]

Atkinson, Richard C., and Richard M. Shiffrin. 1971. *The Control Processes of Short-Term Memory*. Stanford: Institute for Mathematical Studies in the Social Sciences, Stanford University.

Bailey-Ross, Claire, Andrew M. Beresford, Daniel T. Smith, and Claire Warwick. 2017. Aesthetic Appreciation And Spanish Art: Insights from Eye-Tracking. *Digital Scholarship in the Humanities* 34: i17–i35. [CrossRef]

Becker, Stefanie I. 2010. The Role of Target–Distractor Relationships in Guiding Attention and the Eyes in Visual Search. *Journal of Experimental Psychology: General* 139: 247–65. [CrossRef] [PubMed]

Bold, John, and Robert Pickard. 2013. Reconstructing Europe: The Need for Guidelines. *The Historic Environment: Policy & Practice* 4: 105–28. [CrossRef]

Bold, John, Peter Larkham, and Robert Pickard. 2018. *Authentic Reconstruction. Authenicuty, Architecture and the Build Heritage*. London and New York: Bloomsbury.

Canciani, Marco, Corrado Falcolini, Marialetizia Buonfiglio, Stefania Pergola, Mauro Saccone, Bruno Mammì, and Giorgia Romito. 2013. A method for virtual anastylosis: The case of the Arch of Titus at the Circus Maximus in Rome. *ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences II-5 W* 1: 61–66. [CrossRef]

Carter, Benjamin T., and Steven G. Luke. 2020. Best Practices in Eye Tracking Research. *International Journal of Psychophysiology* 155: 49–62. [CrossRef]

Chelazzi, Leonardo, Francesco Marini, David Pascucci, and Massimo Turatto. 2019. Getting Rid of Visual Distractors: The Why, When, How, and Where. *Current Opinion in Psychology, Attention & Perception* 29: 135–47. [CrossRef]

Cheng, Baoquan, Xiaowei Luo, Xiang Mei, Huihua Chen, and Jianling Huang. 2022. A Systematic Review of Eye-Tracking Studies of Construction Safety. *Frontiers in Neuroscience* 16: 891725. [CrossRef] [PubMed]

Coburn, Alex, Oshin Vartanian, and Anjan Chatterjee. 2017. Buildings, beauty, and the brain: A neuroscience of architectural experience. *Journal of Cognitive Neuroscience* 29: 1521–31. [CrossRef] [PubMed]

Czerner, Rafał. 2015. The monumentality retrieved, in other words the anastylosis of the pillar funerary monuments of Marina El-Alamein. *Architectus* 3: 5–12. [CrossRef]

Darda, Kohinoor M., and Emily S. Cross. 2022. A unifying model of visual art appreciation: The role of expertise and culture. *Journal of Vision* 21: 186.

De la Fuente Suárez, Luis Alfonso. 2020. Subjective experience and visual attention to a historic building: A real-world eye-tracking study. *Frontiers of Architectural Research* 9: 774–804. [CrossRef]

Duchowski, Andrew. 2007. Eye movement analysis. In *Eye Tracking Methodology*. London: Springer, pp. 137–53.

Egloff, Brian J. 2019. *Archaeological Heritage Conservation and Management*. Oxfordshire: Archaeopress.

Elitaş, Serpil Kir. 2021. Reshaping of Museums With Experiences: An Examination on the Hatay Archeology Museum. In *Impact of New Media in Tourism*. Pennsylvania: IGI Global, pp. 75–87.

Fager, Susan. K., T. Sorenson, E. Jakobs, H. Koester, T. Jakobs, and D. R. Beukelman. 2022. Multi-modal access method (eye-tracking+ switch-scanning) for individuals with severe motor impairment: A preliminary investigation. *Assistive Technology 1–9*. [CrossRef]

Filali, Hajar, Jamal Riffi, Ilyasse Aboussaleh, Adnane Mohamed Mahraz, and Hamid Tairi. 2022. Meaningful Learning for Deep Facial Emotional Features. *Neural Processing Letters* 54: 387–404. [CrossRef]

Foulsham, Tom, Esther Walker, and Alan Kingstone. 2011. The Where, What and When of Gaze Allocation in the Lab and the Natural Environment. *Vision Research* 51: 1920–31. [CrossRef] [PubMed]

Fouseki, Kalliopi. 2008. *Conflict Resolution in the Management of In-Situ Museums*. London: University of London, University College London.

Fouseki, Kalliopi. 2009. Private preservation versus public presentation: The conservation for display of in situ fragmentary archaeological remains in London and Athens. *Papers from the Institute of Archaeology* 19: 37–54. [CrossRef]

Gaiani, Marco, Fabrizio Ivan Apollonio, Andrea Ballabeni, and Fabio Remondino. 2017. Securing Color Fidelity in 3D Architectural Heritage Scenarios. *Sensors* 17: 2437. [CrossRef]

Galley, Niels, Dirk Betz, and Claudia Biniossek. 2015. Fixation durations-Why are they so highly variable? *Das Ende von Rational Choice? Zur Leistungsfähigkeit der Rational-Choice-Theorie* 93: 1–26.

Gholami, Yasaman, Seyed Hassan Taghvaei, Saeid Norouzian-Maleki, and Rouhollah Mansouri Sepehr. 2021. Identifying the stimulus of visual perception based on Eye-tracking in Urban Parks: Case Study of Mellat Park in Tehran. *Journal of Forest Research* 26: 91–100. [CrossRef]

Gombrich, Ernst. 1984. *The Sense of Order: A Study in the Psychology of Decorative Art*. New York: Phaidon Press.

Gulhan, Doga, Szonya Durant, and Johannes M. Zanker. 2021. Similarity of gaze patterns across physical and virtual versions of an installation artwork. *Scientific Reports* 11: 1–16. [CrossRef]

Ham, Sam H. 2004. Interpretation isn't magic: An academic's view on the role of research in teaching interpretation. *Journal of Interpretation Research* 9: 65–68. [CrossRef]

Hamilakis, Yannis. 2001. *The Responsibilities of Archaeologists. Archaeology and Ethics*. Edited by Mark Pluciennik. BAR International Series 981; Oxford: Archaeopress, pp. 91–99.

Haskins, Amanda J., Jeffrey Mentch, Thomas Botch, Adam Steel, and Caroline Robertson. 2020. Active Vision Impacts How We Move Our Eyes and What We Attend To: Evidence from Eye-tracking in Immersive, 360° Real-World Environments. *Journal of Vision* 20: 1423. [CrossRef]

Hollander, Justin B., Ann Sussman, Alex Purdy Levering, and Cara Foster-Karim. 2020. Using eye-tracking to understand human responses to traditional neighborhood designs. *Planning Practice & Research* 35: 485–509. [CrossRef]

Holmqvist, Kenneth, Saga Lee Örbom, Ignace T. C. Hooge, Diederick C. Niehorster, Robert G. Alexander, Richard Andersson, Jeroen S. Benjamins, Pieter Blignaut, Anne-Marie Brouwer, Lewis L. Chuang, and et al. 2022. Eye tracking: Empirical foundations for a minimal reporting guideline. *Behavior Research Methods 1–53*. [CrossRef]

Huang, Yuedi, and Younghwan Pan. 2021. Discovery and Extraction of Cultural Traits in Intangible Cultural Heritages Based on Kansei Engineering: Taking Zhuang Brocade Weaving Techniques as an Example. *Applied Sciences* 11: 11403. [CrossRef]

ICOMOS. 1964. The Venice Charter for the Conservation and Restoration of Monuments and Sites. Available online: https://www.icomos.org/charters/venice_e.pdf (accessed on 15 December 2022).

ICOMOS. 2008. The Ename Charter on the Interpretation and Presentation of Cultural Heritage Sites, Québec. Available online: http://www.international.icomos.org/charters/interpretation_e.pdf (accessed on 15 December 2022).

ICOMOS. 2013. The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance, Burra. Available online: https://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf (accessed on 15 December 2022).

Irons, Jessica L., and Andrew B. Leber. 2016. Choosing Attentional Control Settings in a Dynamically Changing Environment. *Attention, Perception, & Psychophysics* 78: 2031–48. [CrossRef]

Jaramillo-Contreras, Marcela. 2012. Beyond the Protection of Material Cultural Heritage in Times of Conflict. In *Protecting Cultural Heritage In Times of Conflict*; Rome: ICCROM.

Josephson, Sheree, and Melina Myers. 2019. Augmented reality through the lens of eye tracking. *Visual Communication Quarterly* 26: 208–22. [CrossRef]

Krupina, Anastassia, Vladimir Bespalov, Elizaveta Kovaleva, and Ekaterina Bondarenko. 2017. Eye tracking in urban visual environment. *Stroitel'stvo Unikal'nyh Zdanij i Sooruzenij* 1: 47. [CrossRef]

Kurdy, Micheline, Jean-Luc Biscop, Livio De Luca, and Michel Florenzano. 2011. 3D virtual anastylosis and reconstruction of several buildings in the site of Saint-Simeon, Syria. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* 38: W16. [CrossRef]

Mandolesi, Serena, Danilo Gambelli, Simona Naspetti, and Raffaele Zanoli. 2022. Exploring Visitors' Visual Behavior Using Eye-Tracking: The Case of the "Studiolo Del Duca". *Journal of Imaging* 8: 8. [CrossRef]

Mcgill, Mark, Aidan Kehoe, Euan Freeman, and Stephen Brewster. 2020. Expanding the Bounds of Seated Virtual Workspaces. *ACM Transactions on Computer-Human Interaction (TOCHI)* 27: 1–40. [CrossRef]

Mertens, Dieter. 1984. Planning and Executing Anastylosis of Stone Buildings. In *Conservation of Archaeological Excavations*; Edited by Stanley-Price N. Rome: ICCROM, pp. 121–44.

Mon-Williams, Mark, Anna Plooy, Robin Burgess-Limerick, and John Wann. 1998. Gaze angle: A possible mechanism of visual stress in virtual reality headsets. *Ergonomics* 41: 280–85. [CrossRef] [PubMed]

Nuthmann, Antje, and John M. Henderson. 2010. Object-based attentional selection in scene viewing. *Journal of Vision* 10: 20–20. [CrossRef]

Parowicz, Izabella. 2019. *Cultural Heritage Marketing. A Relationship Marketing Approach to Conservation Services*. London: Palagrave Macmillan.

Pedersen, Isabel, Nathan Gale, Pejman Mirza-Babaei, and Samantha Reid. 2010. More than Meets the Eye: The Benefits of Augmented Reality and Holographic Displays for Digital Cultural Heritage. *Journal on Computing and Cultural Heritage (JOCCH)* 10: 1–15. [CrossRef]

Petzet, Michael. 2002. Anastylosis or Reconstruction–the Conservation Concept for the Remains of the Buddhas of Bamiyan. In *Strategies for the World's Cultural Heritage. Preservation in a Globalised World: Principles, Practices and Perspectives*. Madrid: ICOMOS, pp. 189–92.

Petzet, Michael. 2004. Principles of preservation: An introduction to the International Charters for Conservation and Restoration 40 years after the Venice Charter. In *International Charters for Conservation and Restoration. Monuments & Sites*. München: ICOMOS, pp. 7–29.

Plumhoff, Jordan E., and James A. Schirillo. 2009. Mondrian, Eye Movements, and the Oblique Effect. *Perception* 38: 719–31. [CrossRef] [PubMed]

Poole, A., and Linden J. Ball. 2006. Eye Tracking in Human-Computer Interaction and Usability Research: Current Status and Future Prospects. In *Encyclopedia of Human Computer Interaction*. Ann Arbor: Idea Group Reference, pp. 211–19.

Qiu, Yeshan, Yugang Chen, and Shengquan Che. 2020. Using Eye-tracking and Deep Learning Approach to Promote Naturalness in Urban Landscape. Paper presented at the EGU General Assembly Conference Abstracts EGU2020-6515, Online, May 4–8; p. 6515.

Rainoldi, Mattia, and Mario Jooss. 2020. *Eye Tracking in Tourism*. Cham: Springer.

Raptis, George E., Christos Fidas, and Nikolaos Avouris. 2019. Do game designers' decisions related to visual activities affect knowledge acquisition in cultural heritage games? An evaluation from a human cognitive processing perspective. *Journal on Computing and Cultural Heritage (JOCCH)* 12: 1–25. [CrossRef]

Reitstätter, Luise, Hanna Brinkmann, Thiago Santini, Eva Specker, Zoya Dare, Flora Bakondi, Anna Miscená, Enkelejda Kasneci, Helmut Leder, and Raphael Rosenberg. 2020. The display makes a difference: A mobile eye tracking study on the perception of art before and after a museum's rearrangement. *Journal of Eye Movement Research* 13: 1–29. [CrossRef]

Rusnak, Marta. 2021a. Applicability of Eye Trackers in Marketing Activities Related to Historical Monuments. Comparison of Experts' Predictions and Visual Reactions of Non-Professionals. *Journal of Cultural Heritage* 49: 152–63. [CrossRef]

Rusnak, Marta. 2021b. Eye-Tracking Support for Architects, Conservators, and Museologists. Anastylosis as Pretext for Research and Discussion. *Heritage Science* 9: 81. [CrossRef]

Rusnak, Marta. 2022. 2D and 3D Representation of Objects in Architectural and Heritage Studies: In Search of Gaze Pattern Similarities. *Heritage Science* 10: 1–18. [CrossRef]

Rusnak, Marta, and Ewa Ramus. 2019. With an Eye Tracker at the Warsaw Rising Museum. Valorization of Adaptation of Historical Interiors. *Journal of Heritage Conservation*. [CrossRef]

Salleh, Siti Zuliana, and Abd Razak Bushroa. 2022. Bibliometric and content analysis on publications in digitization technology implementation in cultural heritage for recent five years (2016–2021). *Digital Applications in Archaeology and Cultural Heritage* 25: e00225. [CrossRef]

Savin, Georgiana-Denisse, Cristina Fleșeriu, and Larissa Batrancea. 2022. Eye tracking and tourism research: A systematic literature review. *Journal of Vacation Marketing* 28: 285–302. [CrossRef]

Sroczyńska, Jolanta. 2018. *Prezentacja interpretacyjna zabytków architektury w ochronie dziedzictwa kulturowego*. Kraków: Wydawnictwo PK.

Sroczyńska, Jolanta. 2021. The Social Value of Architectural Monuments in the Light of Selected Documents of UNESCO Icomos, the Council of Europe, Shaping the Theory of Cultural Heritage Protection. *Journal of Heritage Conservation* 65: 7–19. [CrossRef]

Stanco, Filippo, Davide Tanasi, Dario Allegra, Filippo Luigi Maria Milotta, Gioconda Lamagna, and Giuseppina Monterosso. 2017. Virtual anastylosis of Greek sculpture as museum policy for public outreach and cognitive accessibility. *Journal of Electronic Imaging* 26: 011025. [CrossRef]

Sundstedt, Veronica. 2012. Gazing at games: An introduction to eye tracking control. *Synthesis Lectures on Computer Graphics and Animation* 5: 1–113. [CrossRef]

Tatler, Benjamin W., Nicholas J. Wade, Hoi Kwan, John M. Findlay, and Boris M. Velichkovsky. 2010. Yarbus, eye movements, and vision. *i-Perception* 1: 7–27. [CrossRef]

Tobii Pro Site. 2022. Available online: https://www.tobiipro.com/learn-and-support/learn/steps-in-an-eye-tracking-study/run/how-to-position-the-participant-and-the-eye-tracker/ (accessed on 15 December 2022).

Torun, Ebra, and Semih Ercan. 2013. Two Decades of Anastylois Experience at Sagalassos. In *Exempli Gratia. Sagalassos, Marc Waelkens and Interdisciplinary Archaeology*. Leuven: Leuven University Press, vol. 29, pp. 37–38.

Tzi-Dong Ng, Jeremy, Xiao Hu, and Ying Que. 2022. Towards Multi-modal Evaluation of Eye-tracked Virtual Heritage Environment. Paper presented at 12th International Learning Analytics and Knowledge Conference, Online, March 21–25; pp. 451–57. [CrossRef]

Vacharopoulou, Kalliopi. 2006. *Conservation of Classical Monuments: A Study of Anastylosis with Case Studies from Greece and Turkey*. London: University of London.

van Herpen, Erica, Eva van den Broek, Hans CM van Trijp, and Tian Yu. 2016. Can a virtual supermarket bring realism into the lab? Comparing shopping behavior using virtual and pictorial store representations to behavior in a physical store. *Appetite* 107: 196–207. [CrossRef]

Wu, Dan, Shuang Xu, Xiaoyun Xu, and Xi Chen. 2019. Users' visual attention flow on the search result page of digital cultural heritage collection. *Proceedings of the Association for Information Science and Technology* 56: 816–18. [CrossRef]

Zhang, Le-Min, Ruo-Xi Zhang, Tay-Sheng Jeng, and Zi-Yuan Zeng. 2019. Cityscape protection using VR and eye tracking technology. *Journal of Visual Communication and Image Representation* 64: 102639. [CrossRef]

Zimmermann, Eckart. 2020. Saccade suppression depends on context. *Elife* 9: e49700. [CrossRef] [PubMed]

Zou, Zhengbo, and Semiha Ergan. 2019. Where do we look? An eye-tracking study of architectural features in building design. In *Advances in Informatics and Computing in Civil and Construction Engineering*. Cham: Springer, pp. 439–46. [CrossRef]

Zvyagina, Natalya, and Anna Taleeva Assis. 2018. Eye Tracking Parameters as Markers of Urban Architecture Comfort. *International Multidisciplinary Scientific GeoConference: SGEM* 18: 557–64. [CrossRef]