Data in Brief 47 (2023) 108963

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Dataset of virtual and real-life visual experiences inside a museum: survey on visual perception with objective and subjective measures

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ARTICLE INFO

Article history:
Received 4 January 2023
Accepted 30 January 2023
Available online 9 February 2023

Dataset link: Dataset of virtual and real-life visual experiences inside a museum: survey on visual perception with objective and subjective measures - Videos and Questionnaire Results (Original data)

Keywords:
Real-life visual experience
Virtual visual experience
Museums immersion
Lighting evaluation questionnaire
Occupants' perception
Occupant preference dataset
Illuminance measurements dataset
Monumental Charterhouse of Calci

ABSTRACT

Occupants' perception of a space depends on their experience [1–3]. Four kinds of visiting experiences were carried out inside the Natural History Museum of the University of Pisa [4]. The museum is housed, together with the National Museum of the Charterhouse [5], inside the Monumental Charterhouse of Calci, near Pisa. Four of the permanent exhibition halls of the Museum were selected for the survey: Historical Gallery, Mammal's Hall, Ungulates' Gallery and Cetaceans' Gallery. A total of 117 participants were divided into four groups depending on their visiting experience: real-life, or virtual based respectively on videos, photos or computer-generated photorealistic images (renders). Experiences are compared. The comparison comprehends objective data (measured illuminance levels) and subjective data (questionnaire outcomes on the perception of the space). The illuminance levels were measured using a photoradiometer: datalogger Delta Ohm HD2102.2 equipped with LP 471 PHOT probe. The probe was placed 1.20 m above floor level, and it was set to measure vertical illuminance at 10 seconds intervals. To evaluate participants' perception of the space questionnaires were used. The presented data refer to the article: "Perception of light in museum environments: compari-

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https://doi.org/10.1016/j.dib.2023.108963

son between real-life and virtual visual experiences" [1]. This kind of data provides a base to assess if virtual kinds of experience can be implemented in museum environments as an alternative to the real-life experience, and to understand if such an implementation is detrimental or not in terms of participants' perception of the space. Virtual experiences can be particularly useful for spreading culture, making it accessible even in presence of moving restrictions for people, such as those in force today due to the SARS-CoV-2 emergency.

Specifications Table

Subject	Architecture and Engineering
Specific subject area	Impact of virtual or real-life experiences on the visual perception of a museum space.
Type of data	Tables; Graphs; Photos and Videos used for the virtual experiences.
How data were acquired	Illuminance levels were measured with Delta OHM 2102.2 luxmeter; Photos were taken with Nikon D3000 camera; Videos were recorded with GoPRO HERO 7; Participants' evaluations on the space perception were acquired with an ad-hoc questionnaire.
Data format	Raw; Analysed (descriptive statistics).
Parameters for data collection	While measuring vertical illuminance, it was assumed that the participants head (where a recording camera was strapped) and body (where the illuminance probe was strapped) were always aligned. Such assumption is acceptable, as participants were touring the halls and stopped in front of the exhibits to look at them. For the photos and the videos, the cameras' automatic exposure settings were used.
Description of data collection	Using a questionnaire, subjective data on the visual perception inside a museum were acquired. 117 participants performed real-life or virtual experiences before answering the questions. Participants who performed the real-life visits answered the questionnaire after concluding the visiting experience. While touring the exhibition halls, they wore an illuminance probe and a recording camera. Illuminance measures were used to calibre a rendered scene for each exhibition hall. In addition, a photo of each exhibition hall was taken. Illuminance measures, photos and videos were taken on July 2019 the 2nd. Participants who performed the virtual experiences answered the questionnaire in a test room after watching the above-mentioned videos, photos or renders.
Data source location	Natural History Museum, University of Pisa (https://www.msn.unipi.it/it/) Monumental Charterhouse of Calci Calci, Pisa, Tuscany, Italy. 43°43′19″ N; 10°31′22″E
Data accessibility	Illuminance measures, Renders and Photos are within this article. The videos (used for one of the virtual experiences) and the complete results of the questionnaire (used for all the experiences) are in an on-line repository. Repository name: Mendeley Data Digital Object Identifier (DOI): 10.17632/s2v84tvn96.3 Direct URL to data: https://doi.org/10.17632/s2v84tvn96.3
Related research article	A. Çevik, T. Kazanasmaz, G. Tambellini, G. Salvadori, F. Leccese, Perception of Light in Museum Environments: Comparison between Real-Life and Virtual Visual Experiences, Sustainability 2022, 14(21), 14288; https://doi.org/10.3390/su142114288

Value of the Data

- The data in this article provide a base to assess if virtual visiting experiences can be implemented in museum environments as an alternative to real-life experiences.
- The data in this article can help to understand if implementing virtual visiting experiences can be detrimental or not on participants' perception of the space.
- Museum curators can use these data as reference when evaluating the implementation of virtual visits to enhance the cultural offer of their museum.
- Lighting designers can refer to the method hereby used, for similar research.
- Lighting designers can use these data in their research for a comparison with other case studies.

1. Data Description

The data shown in this article are related to the research paper entitled "Perception of light in museum environments: comparison between physical and virtual visual experiences" [1]. In the paper, four exhibition halls of the Natural History Museum of the University of Pisa are analysed. The Museum is housed inside the Monumental Charterhouse of Calci, together with the National Museum of the Charterhouse. The selected are: Historical Gallery (Room A), Mammal's Hall (Room B), Ungulates' Gallery (Room C) and Cetaceans' Gallery (Room D). Table 1 represents the questionnaire sheet used for the subjective survey, the questionnaire is formed by four identical pages, one for each exhibition hall. 117 participants filled the questionnaires, they were divided in four groups (Table 2) depending on their kind of visiting experience: Group 1 "Real-life", Group 2 "Video", Group 3 "Photo" and Group 4 "Render". Fig. 1 represents the statistical sample of the questionnaire. Table 3 and Fig. 2 provide the median, standard deviation and the box-plots of the answers to Questions 1-11. Fig. 3 shows the six points (Question 14 in the questionnaires) for each room. Figs. 4-5 represent the occurrence of the answers to Questions 12 and 13, for each group for each room. Fig. 6 display the occurrence of the answer for Question 14, for each room, for each group. Figs. 7 to 8 represents the measurement points and directions and one subject's tour inside the four exhibition halls. The illuminance values are displayed in Table 4. The columns in Table 4 have different lengths, due to the different time duration of the tour inside the four exhibition halls. The complete answers to the questionnaires submitted to the participants can be consulted in the raw data available on the aforementioned repository (see Specifications Table).

Table 1
Questionnaire used for the survey.

Visual quality of the space	**1**	Lighting type	Natural	Mostly Natural	Both	Mostly Artificial	Artificial
			1	**2**	**3**	**4**	**5**
	2	Glare	Not Apparent	Slight Glare	Normal	Disturbing	Intolerable
			1	**2**	**3**	**4**	**5**
	3	Connection to outdoors	Not Apparent	Weak	Normal	Strong	Very Strong
			1	**2**	**3**	**4**	**5**
	4	Light on objects	Very Dark	Dark	Normal	Bright	Too Bright
			1	**2**	**3**	**4**	**5**
	5	Darkness-lightness of space	Very Dark	Dark	Normal	Bright	Too Bright
			1	**2**	**3**	**4**	**5**
	6	Catchiness of the space	Too Dull	Dull	Normal	Interesting	Very Interesting
			1	**2**	**3**	**4**	**5**
	7	Harshness-softness of light sources	Very Harsh	Harsh	Normal	Soft	Very Soft
			1	**2**	**3**	**4**	**5**
	8	Visual comfort	Very Uncomfortable	Uncomfortable	Normal	Comfortable	Very Comfortable
			1	**2**	**3**	**4**	**5**
	9	Distribution of light	Disturbing	Imbalanced	Fine	Balanced	Perfectly Balanced
			1	**2**	**3**	**4**	**5**
	10	Colour temperature	Too Warm	Warm	Normal	Cold	Too Cold
			1	**2**	**3**	**4**	**5**
	11	Overall quality of space	Very Bad	Bad	Fine	Good	Very Good
			1	**2**	**3**	**4**	**5**
Causes of influence on the visiting experience	**12**	Cause of major influence on the visiting experience (you can choose two)	**a)** interior space		**b)** exhibited objects		**c)** outdoor space
	13	Visual discomfort experienced during the visit (you can choose two)	**a)** reflections	**b)** shadows	**c)** excessive brightness		**d)** none
	14	Please order the points 1 to 6 in the shown picture (according to most disturbing to least disturbing to look).	**1°** _ _	**2°** _ _	**3°** _ _	**4°** _ _	**5** _ _ **6** _ _

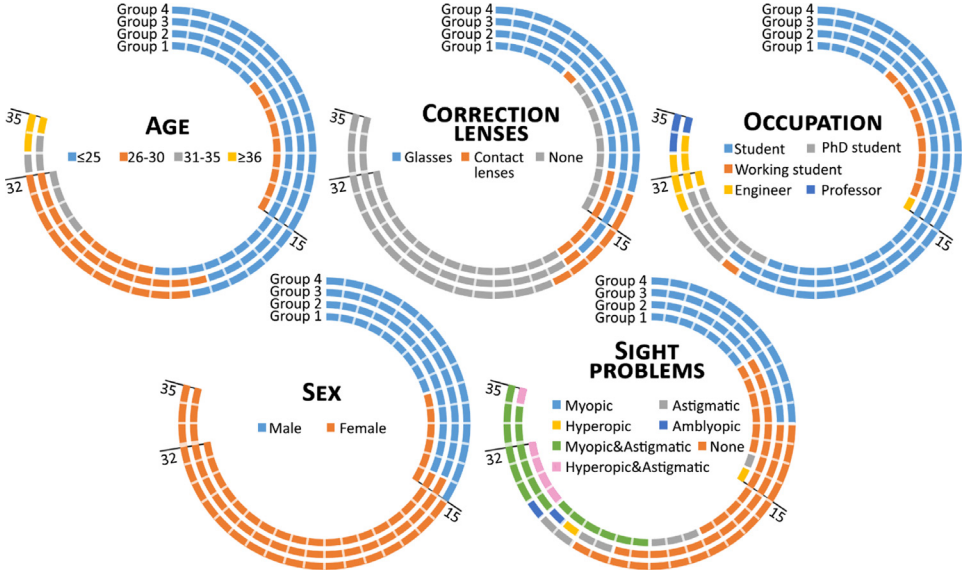

Fig. 1. Sample description of the participants.

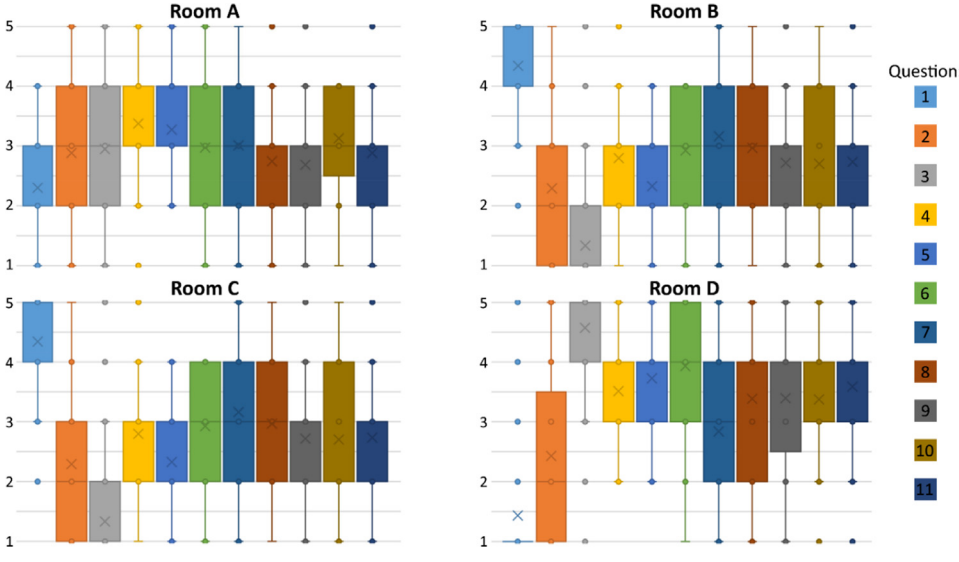

Fig. 2. Box plot of answers to questions 1-11 (answers given by "All Groups", see Table 3).

Table 2
Groups subdivision and characteristics of the 117 participants.

Participants' characteristics		Group			
		1- Real-life	2- Video	3- Photo	4- Render
Age	<25	6	23	20	21
	25-30	9	5	12	11
	31-35	0	4	2	1
	>35	0	0	1	2
Correction lenses	Glasses	5	12	17	13
	Contact lenses	1	6	1	6
	None	9	14	17	16
Occupation	Student	5	25	27	26
	Working student	9	0	0	1
	PhD student	0	6	4	3
	Engineer	1	1	3	3
	Professor	0	0	1	2
Sex	Male	9	14	14	15
	Female	6	18	21	20
Sight problems	Myopic	7	7	11	11
	None	6	12	13	15
	Astigmatic	1	3	2	2
	Hyperopic	1	0	1	0
	Amblyopic	0	0	1	1
	Myopic & Astigmatic	0	6	6	6
	Hyperopic & Astigmatic	0	4	1	0
Total number of participants per Group	15	32	35	35	

Table 3
Median, average and standard deviation for questions 1-11 for each exhibition hall.

Room	Group		Question										
			1	2	3	4	5	6	7	8	9	10	11
A	1	Average	3.2	2.1	2.7	2.8	2.9	3.3	3.3	3.2	2.9	2.7	2.9
		Median	3	2	3	3	3	3	3	3	3	3	3
		Std dev	0.56	1.03	1.10	0.68	0.74	0.72	0.62	0.86	0.80	0.70	0.70
	2	Average	2.3	3.3	3.4	3.6	3.7	3.1	2.9	2.7	2.8	2.8	2.9
		Median	2	4	4	4	4	3	3	3	3	3	3
		Std dev	0.44	1.03	0.91	0.75	0.64	1.13	0.89	0.78	0.87	0.78	0.88
	3	Average	2.3	2.8	2.5	3.5	3.3	2.8	2.9	2.7	2.7	3.5	2.9
		Median	2	2	2	3	3	3	3	3	2	4	3
		Std dev	0.51	1.11	0.92	0.89	0.70	1.00	0.85	0.90	0.80	0.74	0.80
	4	Average	2.0	2.9	3.0	3.2	3.1	2.9	3.1	2.7	2.5	3.2	2.8
		Median	2	3	3	3	3	3	3	3	2	3	3
		Std dev	0.54	1.09	0.98	0.91	0.70	0.76	1.02	0.87	1.01	0.76	0.83
	All	Average	2.3	2.9	3.0	3.4	3.3	3.0	3.0	2.7	2.7	3.1	2.9
	Groups	Median	2	3	3	3	3	3	3	3	2	3	3
		Std dev	0.62	1.12	1.02	0.87	0.74	0.95	0.90	0.86	0.89	0.80	0.81

(*continued on next page*)

Table 3 (*continued*)

Room	Group		Question 1	2	3	4	5	6	7	8	9	10	11
B	1	Average	4.5	2.2	1.2	2.8	2.5	3.1	3.1	2.9	2.9	2.6	2.9
		Median	5	2	1	3	2	3	3	3	3	2	3
		Std dev	0.74	0.94	0.41	0.68	0.83	0.88	1.16	0.59	0.92	0.83	0.74
	2	Average	4.3	2.4	1.4	3.5	2.4	3.1	2.6	2.8	2.5	3.6	2.7
		Median	4	2	1	4	2	3	3	3	2	4	3
		Std dev	0.48	1.04	0.88	0.92	0.62	0.82	0.67	0.78	0.72	0.56	0.65
	3	Average	4.2	2.6	1.2	2.5	2.3	2.7	3.3	2.9	2.7	2.3	2.5
		Median	4	2	1	2	2	3	3	3	3	2	2
		Std dev	0.84	1.00	0.73	0.66	0.83	0.93	0.96	0.98	0.93	0.78	0.89
	4	Average	4.4	1.9	1.4	2.4	2.2	2.9	3.6	3.2	2.9	2.4	3.0
		Median	4	2	1	2	2	3	4	3	3	2	3
		Std dev	0.55	0.99	0.50	0.60	0.71	1.07	0.88	0.79	0.80	0.88	1.03
	All Groups	Average	4.4	2.2	1.3	2.8	2.4	2.8	3.2	3.0	2.7	2.7	2.8
		Median	4	2	1	3	2	3	3	3	3	2	3
		Std dev	0.66	1.03	0.68	0.85	0.74	0.94	0.96	0.83	0.84	0.94	0.87
C	1	Average	3.7	2.3	2.3	3.5	3.1	3.3	2.8	3.4	3.4	2.4	3.3
		Median	4	3	2	4	3	3	3	4	3	2	3
		Std dev	0.90	0.82	0.98	0.52	0.74	0.80	0.86	0.74	0.51	0.51	0.70
	2	Average	2.5	3.2	2.7	3.4	3.4	3.3	3.1	2.9	2.9	2.9	3.0
		Median	3	4	3	3	3	4	3	3	3	3	3
		Std dev	0.72	1.02	0.97	0.56	0.71	1.00	0.82	1.09	0.98	0.61	0.72
	3	Average	2.2	3.1	3.0	3.7	3.5	2.9	2.7	2.6	2.4	2.8	2.7
		Median	2	3	3	4	3	3	3	2	2	3	3
		Std dev	1.06	1.29	1.15	0.71	0.82	1.09	0.84	0.91	0.95	0.63	1.05
	4	Average	2.4	3.6	3.1	3.9	3.8	3.1	2.6	2.5	2.5	2.8	2.7
		Median	1	2	5	4	4	4	2	3	3	4	3
		Std dev	0.96	1.20	0.92	0.66	0.56	1.08	1.16	1.00	0.99	0.74	0.93
	All Groups	Average	2.5	3.2	2.9	3.7	3.5	3.1	2.8	2.7	2.7	2.8	2.9
		Median	3	3	3	4	3	3	3	2	3	3	3
		Std dev	0.99	1.13	1.05	0.66	0.76	0.97	0.83	0.96	0.95	0.64	0.94
D	1	Average	2.9	1.7	4.5	3.2	3.3	4.3	3.1	3.2	3.3	3.2	3.5
		Median	2	1	5	3	3	4	3	3	3	3	3
		Std dev	1.85	0.98	0.83	0.77	0.96	0.80	1.03	0.94	1.03	0.94	1.06
	2	Average	1.2	2.9	4.6	3.5	3.8	3.8	3.0	3.3	3.2	3.1	3.6
		Median	1	3	5	3	4	4	3	4	3	3	4
		Std dev	0.64	1.08	0.87	0.62	0.71	1.04	0.84	1.15	1.04	0.78	1.07
	3	Average	1.2	2.0	4.6	3.7	3.9	4.2	2.8	3.7	3.9	3.5	3.9
		Median	1	2	5	4	4	4	3	4	4	3	4
		Std dev	0.38	1.15	0.49	0.62	0.65	0.92	1.29	1.05	1.02	0.74	1.04
	4	Average	1.3	2.7	4.5	3.5	3.7	3.7	2.7	3.2	3.1	3.6	3.3
		Median	1	2	5	4	4	4	2	3	3	4	3
		Std dev	0.96	1.20	0.92	0.66	0.56	1.08	1.16	1.00	0.99	0.74	0.93
	All Groups	Average	1.4	2.4	4.6	3.5	3.7	3.9	2.8	3.4	3.4	3.4	3.6
		Median	1	2	5	3	4	4	3	4	4	3	4
		Std dev	1.07	1.21	0.78	0.66	0.70	1.01	1.11	1.06	1.06	0.80	1.04

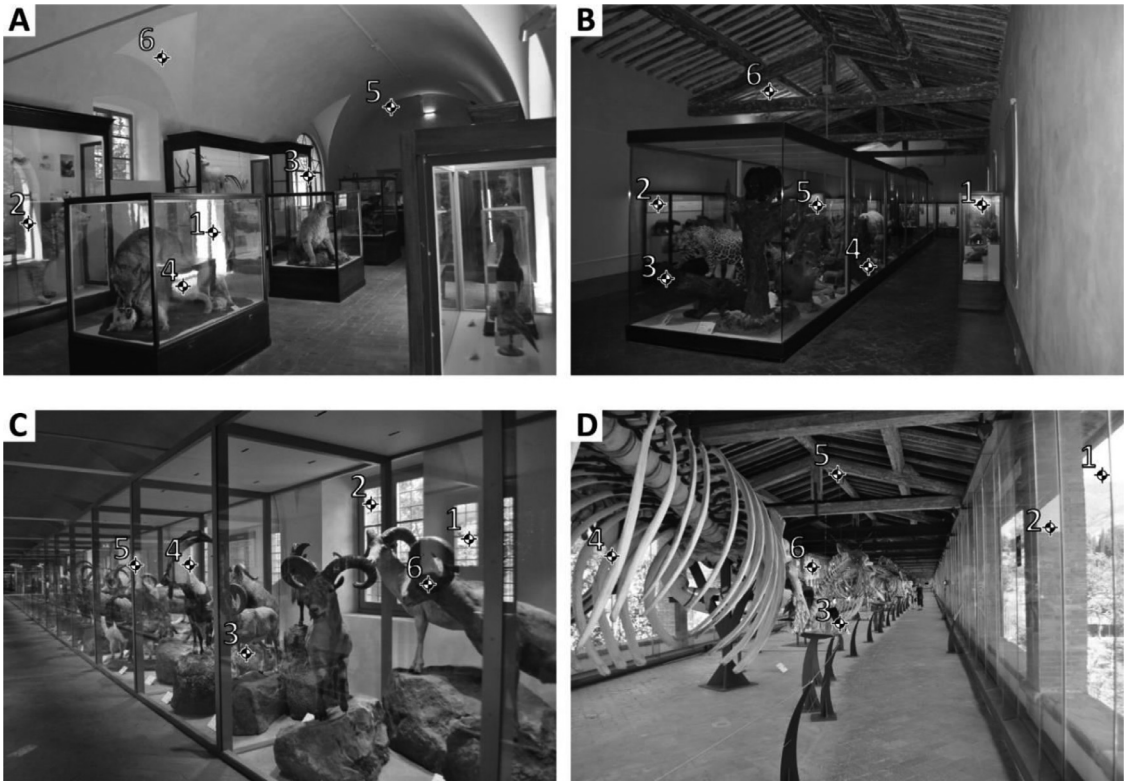

Fig. 3. Reference pictures of the exhibition halls, with the six points highlighted for Question 14.

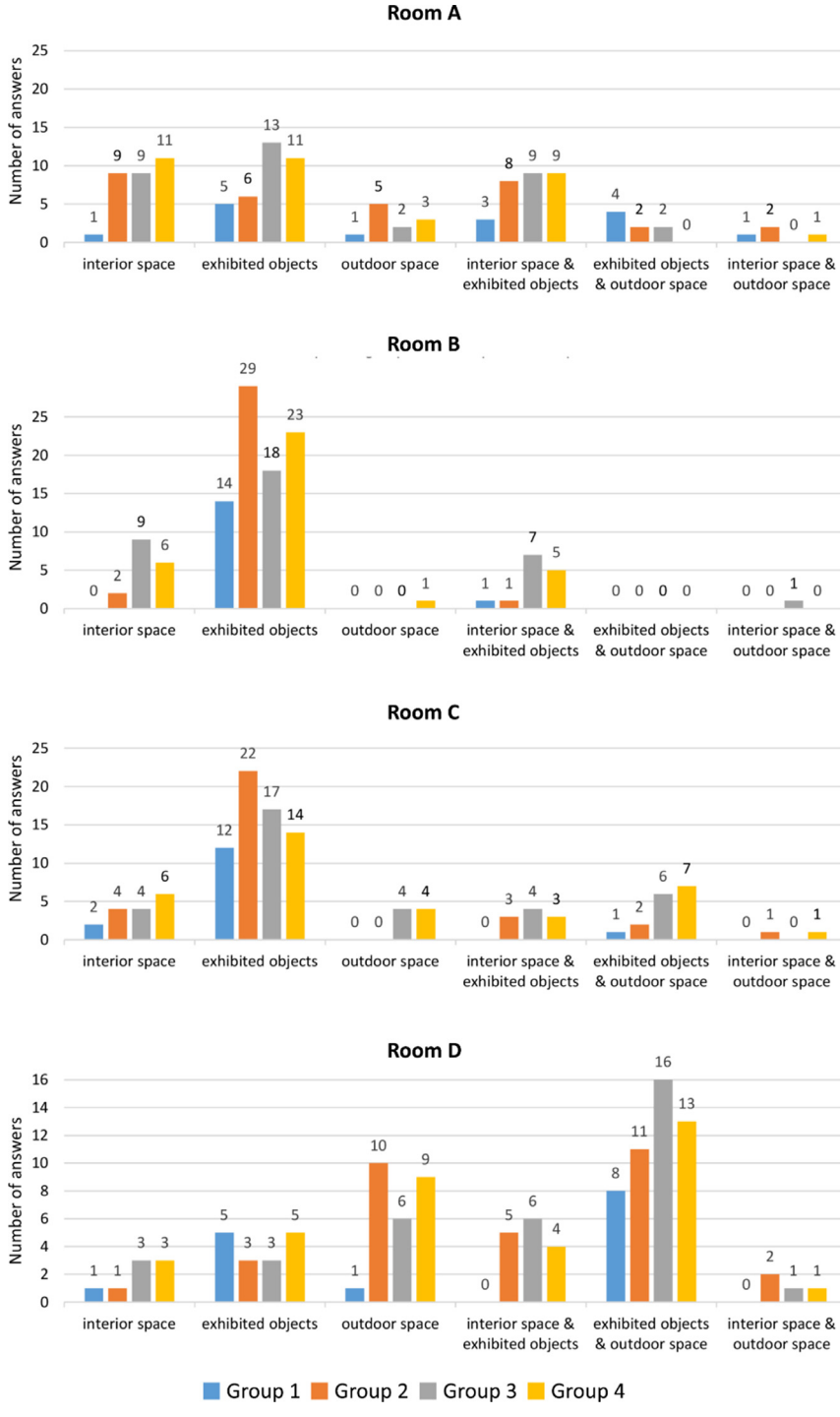

Fig. 4. Results for Question 12 for each exhibition hall.

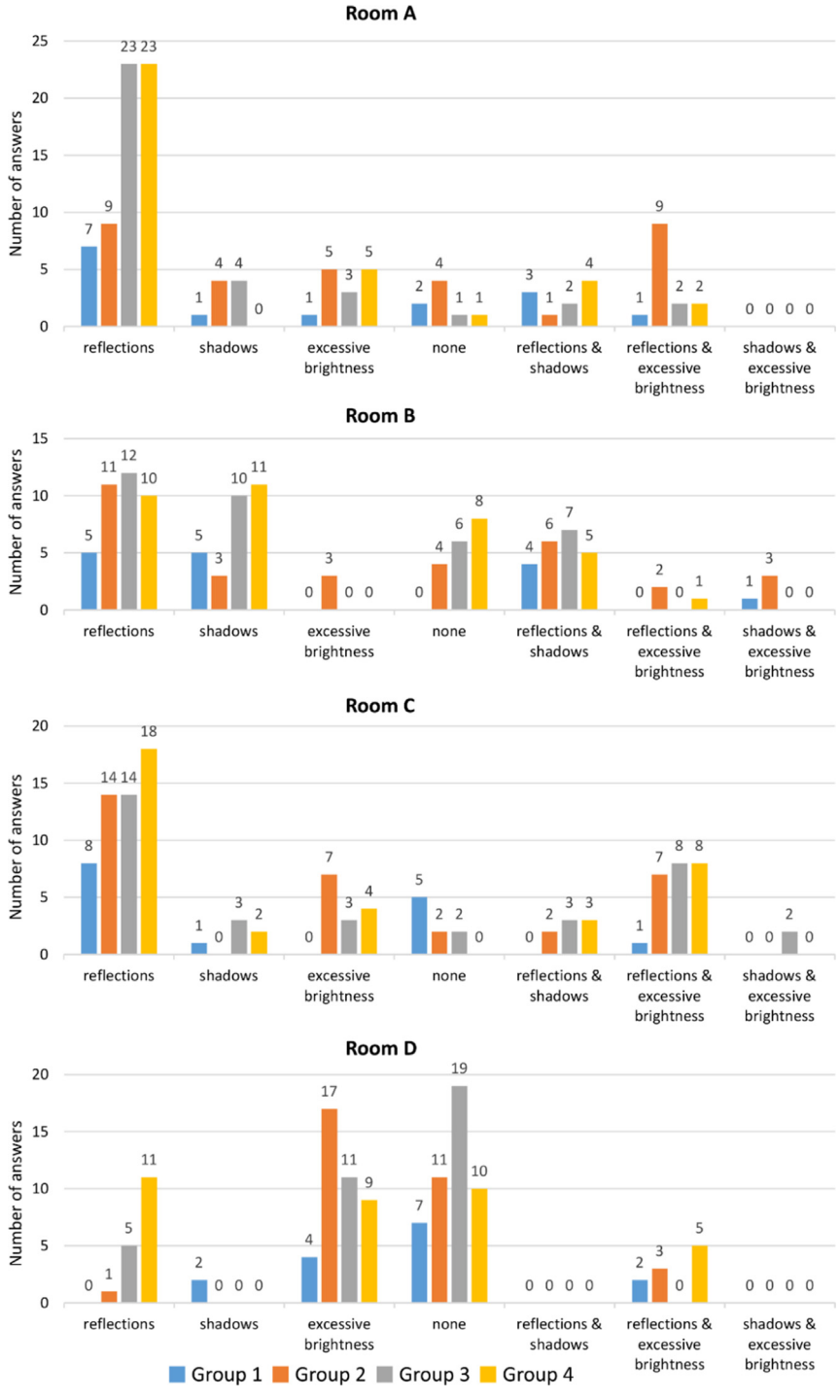

Fig. 5. Results for Question 13 for each exhibition hall.

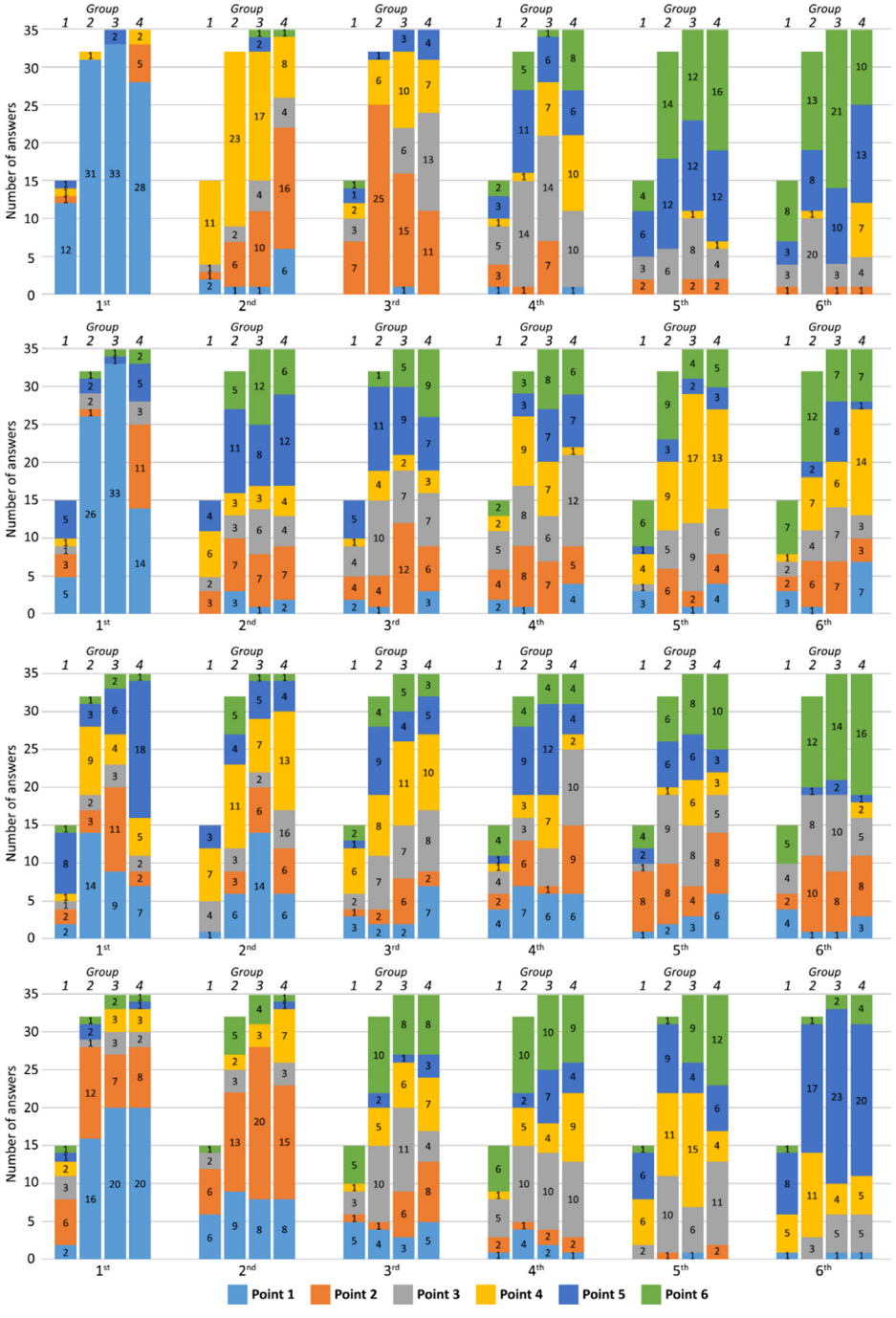

Fig. 6. Results for Question 14 for each exhibition hall (for each point shown in Fig. 3).

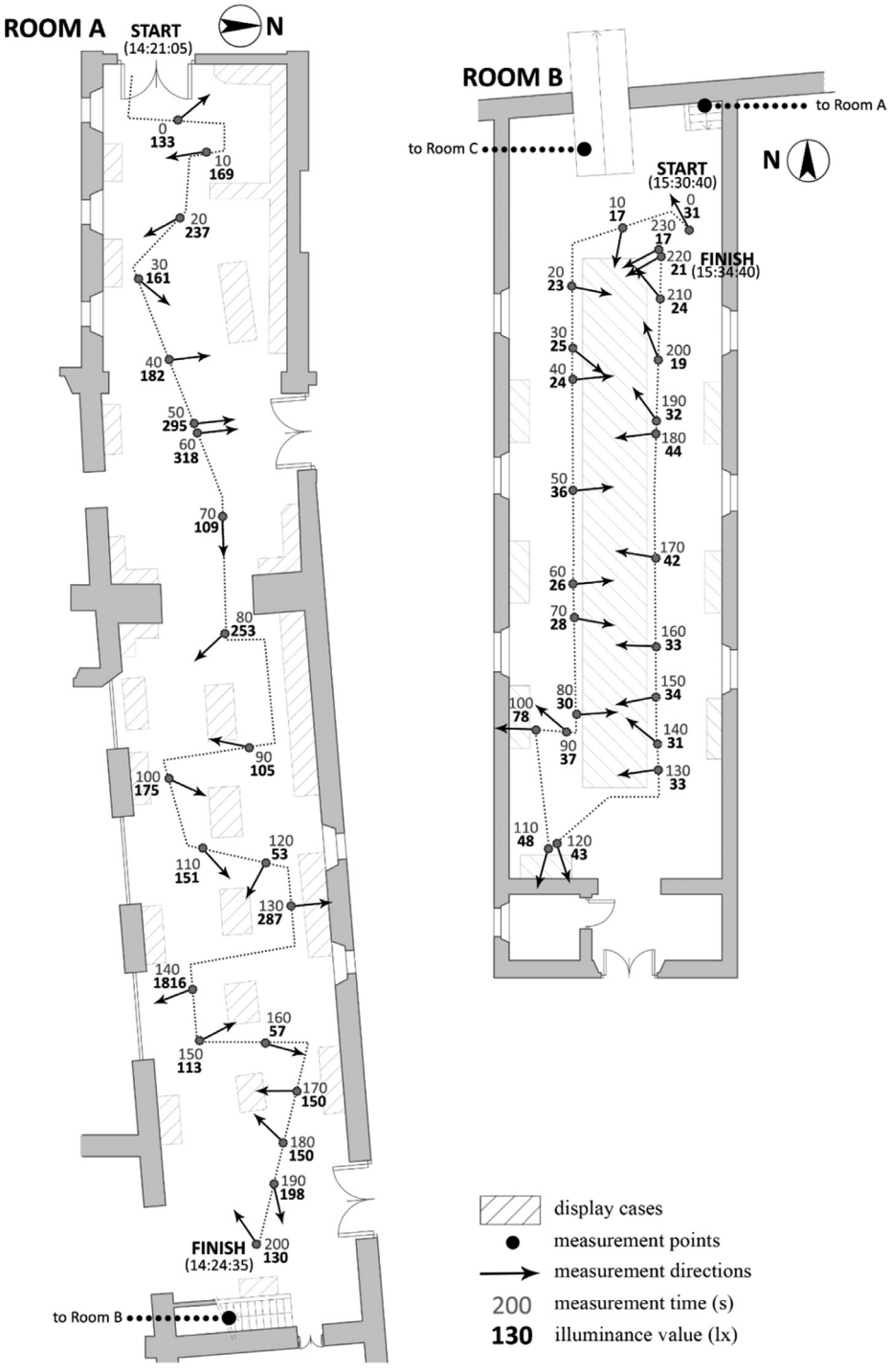

Fig. 7. Vertical illuminance measurements: points directions, time and values; (left) Room A; (right) Room B (drawings not in scale).

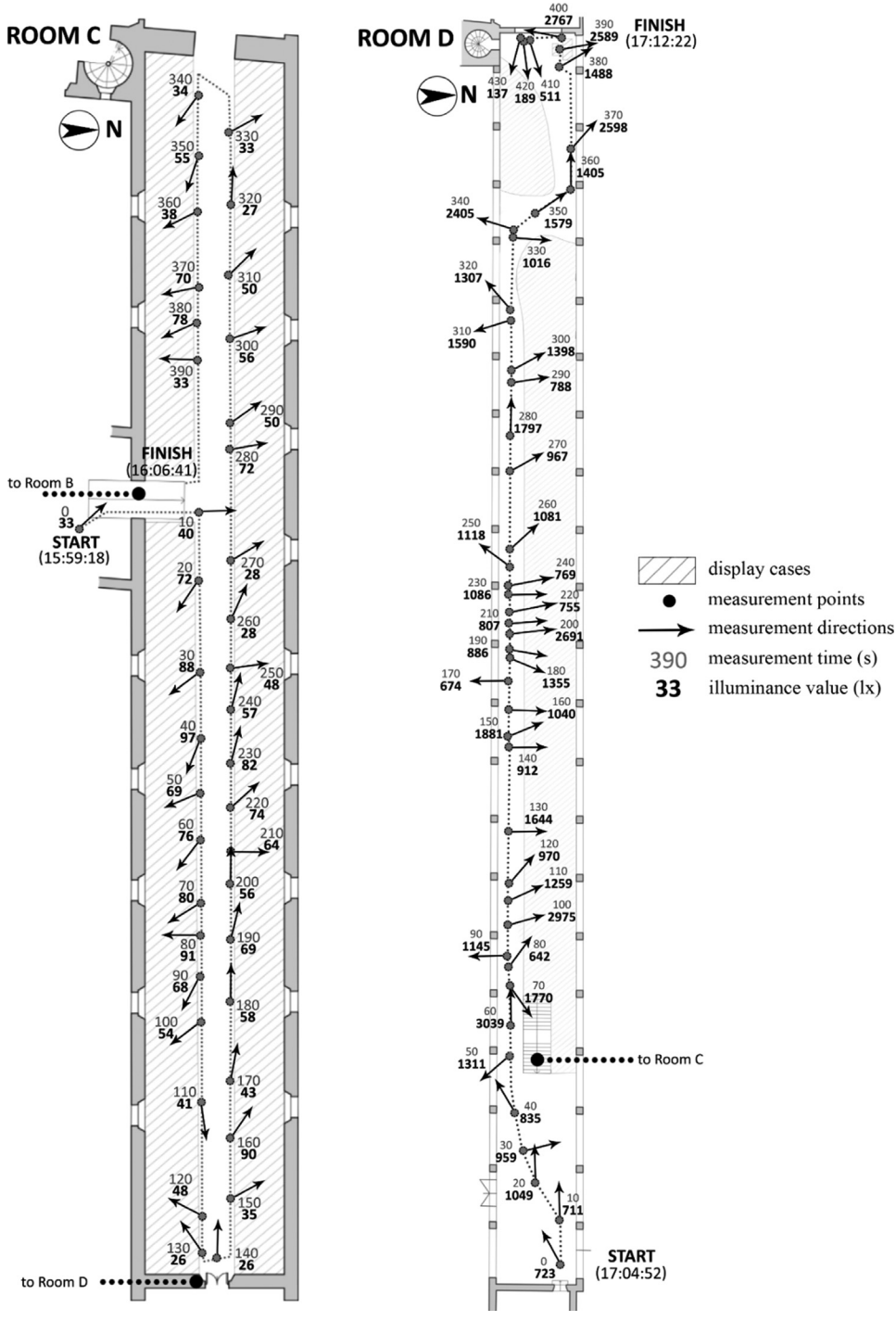

Fig. 8. Vertical illuminance measurements: points directions, time and values. (left) Room C (right) Room D. (Drawings not in scale).

Table 4
Vertical illuminance levels inside the exhibition halls (lx).

Measurement time (s)	Room A	Room B	Room C	Room D
0	133	31	33	723
10	169	17	40	711
20	237	23	72	1049
30	161	25	88	959
40	182	24	97	835
50	295	36	69	1131
60	318	26	76	3039
70	109	28	80	1770
80	253	30	91	642
90	105	37	68	1145
100	175	78	54	2975
110	151	48	41	1259
120	53	43	48	970
130	287	33	26	1644
140	1816	31	26	912
150	113	34	35	1881
160	57	33	90	1040
170	150	42	43	674
180	150	44	58	1355
190	198	32	69	886
200	130	19	56	2691
210		24	64	807
220		21	74	755
230		17	82	1086
240			57	769
250			48	1118
260			28	1081
270			28	967
280			72	1797
290			50	788
300			56	1398
310			50	1590
320			27	1307
330			33	1016
340			34	2405
350			55	1579
360			38	1405
370			70	2598
380			78	1488
390			33	2589
400				2767
410				511
420				189
430				137

2. Experimental Design, Materials and Methods

A 14-points questionnaire was formulated (Table 1) and administrated to 117 between Italian and Turkish participants. Participants were divided into four groups. Group 1 (15 participants) performed real-life visits, at the end of their experience they directly filled the questionnaire on-site. Group 1 participants wore wearable instruments (a photoradiometer and a recording camera), so that they were able to freely tour inside the exhibition hall without constraints. The photoradiometer was composed of a datalogger (Delta Ohm HD2102.2) and a probe to measure illuminance (LP 471 PHOT probe). The probe is able to measure the illuminance from 0 lx to 20000 lx, with a resolution of 1 lx and a linearity deviation lower than 1%. Participants wore

the probe around their neck. For each participants the probe was adjusted in order to place it 1.20 m above floor level. Using this configuration, the probe measures vertical illuminance, in the direction of view. It was assumed that the participants' head and body were always aligned, that is acceptable considering that the participants were freely moving inside the halls and stopped in front of the exhibits in order to look at them. The datalogger was set to measure the illuminance values at 10 seconds intervals. The recording camera was a GoPRO HERO 7, it was mounted with head strap. The videos were used for defining the subject position inside the hall and to reconstruct his/her tour. In addition, the videos allowed to identify the measurement points and the measurement directions. In fact, the advantage due to the wearable (participants freely touring) is balanced by not being able to choose the measurement points. To address this issue, participants were asked to start the tour only after hearing the signal of the datalogger: each measure, at 10 seconds intervals, is signalled by an acoustic signal. This way, by watching the videos, it became possible to identify the exact measurements points, and based on the view target the measuring directions could be defined. The illuminance measures were used to calibrate rendered scene of the exhibition halls in Relux lighting design software. The videos were shown to Group 2 subjects (32 participants) before they answered the questionnaire. The renders were shown to Group 4 subjects (35 participants) before they answered the questionnaire. Group 3 subjects (35 participants) were shown a photo of each exhibition hall before they answered the questionnaire. Renders used by Group 4 subjects and the photos used by Group 3 subjects depicted the same scenes. Groups 2, 3 and 4 participants answered the questionnaire in a controlled test room inside the laboratories of the School of engineering of Pisa and the Izmir Institute of Technology (depending on if they were Italian or Turkish).

Ethics Statements

Informed Consent Statement. The authors declare that all the subjects who participated in the subjective survey, described in the main research article ("Perception of Light in Museum Environments: Comparison between Real-Life and Virtual Visual Experiences" https://doi.org/10.3390/su142114288) which the dataset is referred to, have done it:

- voluntarily and without any conditioning;
- completely free of compensation;
- after having read and accepted the "Information sheet" regarding the aims and characteristics of the research, of which a copy was provided to each participant in English, Italian or Turkish language, as preferred by the participant.

Moreover, the authors declare that the questionnaire submitted to each participant is structured in a completely anonymous way and no information that can be directly associated with the participant (e.g. name, surname, telephone, e-mail or residential address, etc.) was acquired during the survey.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Data Availability

Dataset of virtual and real-life visual experiences inside a museum: survey on visual perception with objective and subjective measures - Videos and Questionnaire Results (Original data) (Mendeley Data).

CRediT Author Statement

Giacomo Salvadori: Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition; **Giuseppe Tambellini:** Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; **Aslıhan Çevik:** Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; **Zehra Tuğçe Kazanasmaz:** Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; **Francesco Leccese:** Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition.

Acknowledgments

Funding: this research was partially funded by the University of Pisa as part of the biennial project: <*Technical committee for the predisposition of cognitive studies aimed to the restoration, the conservation and the enhancement of the Monumental Charterhouse of Calci and its Museums*> (2017-2019), University of Pisa board resolution N°7/2017, concerning thermal, acoustic and lighting analysis. The project involves the University of Pisa (Technical Office for the Management and the Maintenance Activities on the building heritage, and School of Engineering), the Italian Ministry of Cultural Heritage and Activities, the Italian Heritage Protection Department.

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