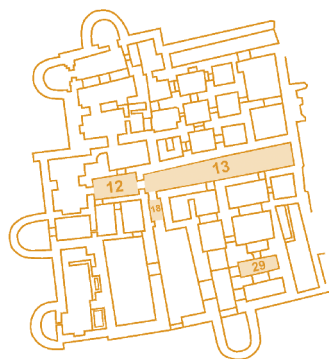


# Impact of viewing time on aesthetic experience of Christian medieval Nubian wall paintings: an eye-tracking study with Sudanese and Western viewers



**Abstract:** Aesthetic experience may foster positive connections between visitors and heritage sites. However, the way people engage with and esthetically experience archaeological heritage is not yet well understood. To address this gap, in the present on-site study, we explored how viewers' cultural backgrounds might influence their aesthetic experience of Christian medieval Nubian wall paintings. Specifically, Sudanese and Western subjects were asked to view 17 paintings from the Monastery on Kom H in Old Dongola (Sudan) while their eye movements and fixations were recorded with a mobile eye-tracker. After the viewing session, participants reported which paintings they preferred and would select for a museum exhibition. Our analysis explored whether and how viewing time on the entire wall painting, and on its specific elements (faces of characters depicted in the paintings and areas outside the faces), mediated later aesthetic choices. The results showed that the viewing time partly predicts the aesthetic choices of participants from both groups. Interestingly, although both groups based their aesthetic choices on viewing faces, the Western viewers were more inclined to do so than the Sudanese participants. Overall, the study supports the idea that cultural background can influence how viewers visually engage with heritage, which in turn partly affects their aesthetic choices. In addition, the research outcome demonstrates that recording eye movements and fixations may foster our understanding of ways viewers engage with archaeological heritage.

**Keywords:** aesthetic experience, eye-tracking, Christian medieval Nubian wall paintings, cross-cultural studies, Sudanese and Western viewers

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### **Acknowledgments**

We would like to thank all participants in the study for their positive response and engagement in our research. We also thank Dr. Tomomi Fushiya, Mohamed Hassan Siedahmed, and Marwa Satti for their invaluable help in organizing the research.

This work was supported by the Excellence Initiative—Research University Programme Action I.3.10 “Archaeooriental Studies”, implemented by the University of Warsaw, and the grant “Kyriakós oíkos? Diachronic conceptualisation of the space and function of Medieval Nubian churches” funded from the National Science Centre, Poland (grant No. 2021/42/E/HS3/00381).

## INTRODUCTION

Heritage appreciation is an important aspect of building relationships between visitors and heritage sites. Alongside authenticity, cultural, historical, and personal connection, or cultural relevance, one of the factors enhancing heritage appreciation is aesthetic experience (Maitland and Smith 2009; W. Yang et al. 2022; Zhou, Chen, and Wu 2022; Ho, Szubiel-ska, and Kopiś-Posiej 2023; Colwill 2024; Zheng, Wei, and Tasci 2024). Aesthetic experience boosts tourists' satisfaction and loyalty to natural and cultural heritage sites (e.g. Breiby and Slåtten 2018; Lu et al. 2020). Moreover, aesthetic appreciation plays an important role in creating memories of heritage site visits, as aesthetically pleasing artworks and the context in which they are displayed are more likely to be remembered than those lacking such qualities (e.g. Brieber, Nadal, and Leder 2015; Babo-Rebelo et al. 2022; however, see Davis and Bainbridge 2023 for contradictory results). Finally, it is the beauty of specific monuments or landscapes that makes tourists undertake hardships of long travels (Deng, Lin, and Chen 2021).

Recent studies suggest that personality type (Palumbo et al. 2025), gender (Cela-Conde et al. 2009), level of art expertise (Pihko et al. 2011), or cultural background (Ho, Szubiel-ska, and Kopiś-Posiej 2023) may shape a viewer's aesthetic experience. However, what actually makes archaeological heritage aesthetically appealing to diverse groups of visitors remains unclear (see also Kirillova 2023 for a broader discussion on tourism research). To better under-

stand the essence of aesthetic experience in archaeological context, in the present study we asked both Sudanese and Western visitors to the archaeological site to view a set of wall paintings and report their aesthetic preferences. We aimed to explore how the time spent on viewing wall paintings in the context of a heritage site influenced the aesthetic experience of people of diverse cultural backgrounds. By understanding this relationship, we hope to enhance our knowledge on how stakeholders of the Old Dongola archaeological site experience this historic place. Rather than evaluating a comprehensive theory of cross-cultural perceptual differences, our focus was on contributing to the site's experience for both the local and international community.

One of the methods to assess a painting viewing experience consists in recording where the viewers look, and for how long they keep looking there. Using eye-tracking to record the distribution and duration of eye fixations has proved to be a reliable method of measuring viewers' engagement in processing visual stimuli (Duchowski 2017), including visual processing of art. Visuo-cognitive literature provides evidence of a positive relation between aesthetic experience and viewing times. For example, Brieber and colleagues (2014) showed that paintings that elicited greater liking and interest were viewed for a longer time than those that were less appreciated. Similarly, a positive relationship between viewing time and aesthetic experience was demonstrated by Mitschke, Goller, and Leder (2017) in research on

the appreciation of street art, as well as by Ganczarek and colleagues (2022) in a study on visual processing of contemporary paintings (see also Holmes and Zanker 2012; Celikors and Sims 2019; Scott et al. 2020).

In the case of figurative paintings, the link between the viewing time and the aesthetic experience may be influenced by the presence of faces depicted therein. Among all visual stimuli, faces are indeed unique since they convey socio-cognitive information (e.g. Leopold and Rhodes 2010; Todorov 2012; Bayet and Nelson 2020) and their attentional prioritization has a neurobiological basis (Haxby, Hoffman, and Gobbini 2000; Tsao et al. 2006). For example, faces perceived as attractive capture and maintain viewers' attention (Maner et al. 2003). Slater and colleagues (1998) have demonstrated that even newborns tend to spend more time looking at faces that adults perceive as attractive, rather than at unattractive ones (see also Leder et al. 2010; Leder, Mitrovic, and Goller 2016 for an example of studies with adults).

Depictions of faces may influence the overall judgement of aesthetic quality of a painting. For example, in a study on visual processing of 19th-century portraits, Trawiński and colleagues (2021) found a positive correlation between portrait appreciation and fixation duration on faces. Similar results were reported by Savazzi and colleagues (2014) in a study on the appreciation of figurative paintings, showing a positive correlation between the longer fixation duration on the faces and the paintings' liking.

Nevertheless, there is also some evidence that features painted outside the face area may influence aesthetic judgements. In his research on the appreciation of 16th- to 18th-century portraits, Francuz (2013) observed that differences in viewing patterns between paintings regarded as beautiful and those categorized as non-beautiful were reflected in participants' fixations on features outside the face area (Francuz 2013: 287–295). Specifically, Francuz reported that, in the case of portraits classified as beautiful, participants spent more time looking at areas outside the faces than when viewing portraits classified as non-beautiful. This finding is partly supported by Trawiński and colleagues (2021), who suggested that salient features in the background may guide viewers' fixations toward faces. Thus, areas outside faces can actively contribute to aesthetic judgments even while they are not directly inspected.

Although visuo-cognitive literature provides robust evidence that aesthetic experience is related to where and for how long viewers focus their attention on paintings, little is known about how spectators of various cultural backgrounds aesthetically experience paintings that are an integral part of archaeological heritage. Cross-cultural studies suggest that cultural background impacts image perception. For example, Chua, Boland, and Nisbett (2005) reported that participants from collectivistic cultures (e.g. East Asian) perform balanced fixations to the focal object and background, whereas participants from individualistic cultures (e.g. Western) tend to focus more on focal objects (see also Goh, Tan, and Park 2009; Duan, Wang,

and Hong 2016; Šašinková et al. 2023). In the context of art recipients, research on cultural-match effects shows that viewers tend to appreciate historical art from their own culture more than art from other cultures (Bao et al. 2016; T. Yang et al. 2019; Ho, Szubielska, and Kopiś-Posiej 2023). This preference may be influenced, among others, by the presence of faces in historical artworks that match the viewers' ethnic backgrounds. Trawiński and colleagues (2023) showed that participants looked longer at faces corresponding with their own ethnicity than at those that did not (see also Trawiński, Zang et al. 2024). Hence, if the viewers' cultural background predicts the level of appreciation of artworks, then the time spent viewing specific areas of a painting may moderate the magnitude of this effect (Palumbo et al. 2025).

We tested this proposition by conducting a series of mediation models that considered the total fixation duration on paintings as a mediator of the effect of viewers' cultural backgrounds on their aesthetic choices. The wall paintings selected for this study were examples of the 11th to 13th-century Christian medieval Nubian art which depicted human figures with attributes. Considering the figurative nature of these paintings, we first analyzed the mediating role of total fixation durations to entire paintings to demonstrate the importance of viewing time in formulating aesthetic responses. Then, we conducted two additional sets of mediation analyses that tested the total fixation duration directed at the faces and the areas beyond them



Fig. 1. Fragment of painting No. 68 "Christ and College of Apostles" (A) and 46 "Apostolic College" (B) divided into Areas of Interest (pink – area of face, yellow – area outside face) (Photos and processing T. Michalik)

[Fig. 1]. Taken together, this analysis aims to enhance our understanding of how viewers' cultural backgrounds affect their aesthetic experiences and

thus enhance our knowledge of the relationship between visual engagement in elements of archaeological heritage and viewers' aesthetic choices.

## MATERIALS AND METHODS

### PARTICIPANTS

Forty-eight Sudanese participants (34 males, 14 females;  $M=34$ ,  $SD=12.7$ ) and 19 representatives of Western cultures (9 males, 10 females;  $M=41.9$ ,  $SD=13.4$ ) took part in the study conducted in November–December 2022. The Sudanese group consisted of the members of the local community from towns located near the Old Dongola archaeological site, while the Western group included White tourists from the US and European countries and members of the archaeological mis-

sion. The inclusion/exclusion criterion for participation in the study was vision correction. We included only those participants who had no greater visual deficits than what could be corrected by lenses supplied by the eye-tracker ( $-5$  to  $+3.5$  diopters).

Most of the participants ( $N=49$ ) saw the paintings for the first time and there was no difference between the Sudanese and Western participants in relation to prior exposure to the paintings ( $\chi^2$  (1,  $N=67$ ) $=2.13$ ,  $p=.143$ ).

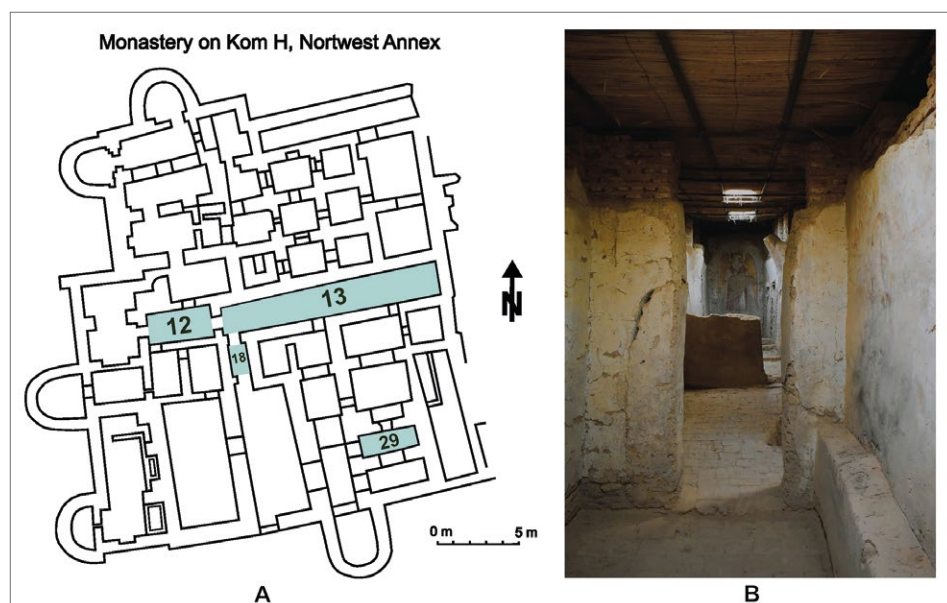


Fig. 2. Scheme of the Northwest Annex of the Monastery on Kom H. Green areas indicate the rooms where the eye-tracking study was conducted (A); view from Room 12 into Room 13 (B) (Photos and processing T. Michalik, based on a plan by M. Puskarski | materials from the PCMA UW Archiving Department)

All participants gave their written consent prior to the study. The study was approved by the Committee for the Ethics of Research Involving Human Participants at the University of Warsaw (Identification code: 112/2021).

### STIMULI

Seventeen paintings from four rooms (Nos 12, 13, 18, and 29) of the Northwest Annex of the Monastery on Kom H at the Old Dongola archaeological site were selected for the study (Martens-Czarnecka 2011: 54, see also [Fig. 2]). They date to the second half of the 11th century and the second half of the 12th/beginning of the 13th century and depict holy figures, biblical scenes, local Nubian rulers, and Church officials (Martens-Czarnecka 2011: 34–39). Most of the wall paintings selected as stimuli depict figures in static poses, with only three featuring more dynamic biblical scenes (see paintings Nos 24, 48, and 69; Martens-Czarnecka 2011). The most common figures in the paintings are archangels, Christ, the Apostles, the Holy Trinity, saints, as well as donors, bishops, and local Nubian rulers. The biblical scenes include the Story of Balaam, the Healing of a Blind Man at

the Pool of Siloam, and the Three Youths in the Fiery Furnace. The wall paintings vary in their state of preservation; however, their original location provides a unique opportunity to explore the aesthetic experience of visitors in an authentic historical context [Fig. 3]. For a detailed description of the stimuli set, see Michalik and colleagues (in preparation).

In each painting we distinguished two Areas of Interest (AOI) — “faces” and “areas beyond faces”. The AOI “faces” included the figure’s face with any facial features (e.g. hair and/or beard) if present. The AOI “beyond faces” included the rest of the figure (body, clothes) and any attributes and contextual information accompanying the figure [see Fig. 1]. This could be either a surface with a uniform color separated from the rest of the wall by a line (see blue surroundings in [Fig. 1:A] and white surroundings in [Fig. 1:B]) or narrative elements (see, for example, clouds behind the authority figure in [Fig. 3:A]). Where the surroundings of the painting did not stand out from the rest of the wall, the background was not marked, and the AOI “beyond faces” included only body/clothes and attributes.

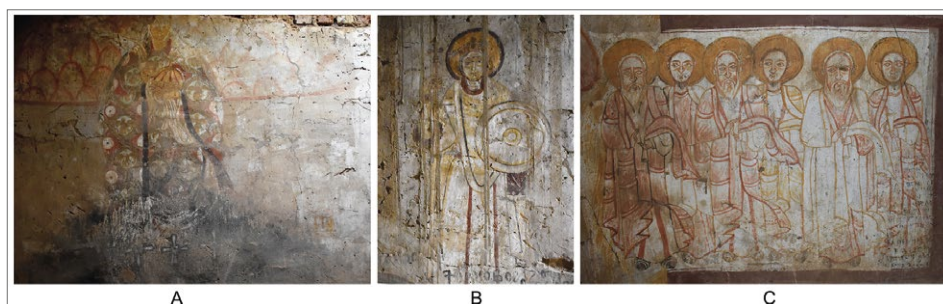


Fig. 3. Examples of paintings Nos 18, 66, 46 from the Monastery on Kom H used as stimuli: (A) Nubian king crowned by the Holy Trinity, (B) Warrior Saint, (C) Apostolic College (Photos and processing T. Michalik)

## APPARATUS

The gaze behaviors of participants were recorded using Tobii Pro Glasses 3. Data were collected at a sampling rate of 100 Hz. The eye-tracker recorded both eyes using the corneal reflection technique and mapped gaze locations onto first-person video through the eye-gaze localization system (Holmqvist et al. 2011).

We used Tobii Pro Lab version 1.194.41215 to process the data. Fixations were classified with the I-VT Attention algorithm and mapped through the Tobii Analyzer Pro Real-World Mapping function. The mapped gaze data were manually reviewed and corrected as needed.

## PROCEDURE

The study was conducted in two stages at fixed times of the day (morning and afternoon), ensuring good visibility of the paintings thanks to natural lighting provided by a skylight. Throughout the study the weather remained sunny and cloudless.

In the first stage, participants' gaze patterns were recorded using a mobile eye-tracker. In this stage, the participants were asked to attend and view the paintings without any specific instructions. In this way, we recorded gaze behaviors without priming them with a specific task to capture natural viewing patterns. Our primary goal was to determine whether such natural gaze behaviors would be related with subsequent aesthetic choices (see for example Brieber et al. 2014; Marin and Leder 2022), as the relationship between preference judgments and eye movements remains a topic of debate in cross-cultural studies (e.g. Ho, Szubielska, and Kapiś-Posiej 2023).

All participants started their viewing experience in the same place (near painting No. 18, Room 12) and visited Rooms 12, 13, and 18 (group 1) followed by a visit to Room 29 (group 2) [see Fig. 2]. Prior to visiting each group of the rooms, a calibration procedure was conducted, during which the participants were presented with a calibration card and were asked to fixate a black dot in its center. The participants were free in the way they viewed the paintings and could revisit the paintings if needed. After the viewing session, the eye-tracker was disassembled, and then the researcher and participant returned to the paintings for the second stage of the study. For a detailed account on the eye-tracking part of the study, see Michalik and colleagues (in preparation).

In the second stage, participants were asked to make aesthetic judgments by responding to the following instructions:

"Imagine you are the director of a museum preparing an exhibition of the most beautiful paintings from the monastery. Your task is to select the most beautiful paintings from those you have seen. The number of paintings you choose is up to you but remember you must make a selection and cannot choose all of them. As you make your selections, please explain why you find each painting appealing."

The respondents' choices were marked on a monastery plan containing all paintings. The rationale behind their choices was recorded on a voice recorder and then transcribed. When needed, an Arabic-to-English interpreter assisted the participants.

In this study, we explore the relationship between viewing time and aesthetic choices, and thus focus on the eye-tracking data rather than verbal responses.

## RESULTS

The results are presented in two parts. First, we provide a descriptive analysis of the data, and then the mediation analyses.<sup>1</sup>

### DESCRIPTIVE RESULTS

The summary probabilities of aesthetic choice for the Sudanese and Western visitors across all paintings, plotted against total viewing time, are presented in [Fig. 4]. On average, the Sudanese visitors viewed each artwork for 14.31 seconds ( $SD=10.18$ ), while for the Western participants the average viewing time was 17.45 seconds ( $SD=11.78$ ). The mean probability of aesthetic choice was 0.14 for the Sudanese viewers and 0.28 for the Western viewers, indicating that the latter ones were nearly twice as likely to select paintings based on their perceived beauty. However, both groups consistently identified painting No. 65 (depicting Archangel Michael) as aesthetically appealing.

Interestingly, while total viewing time largely aligned with aesthetic choices for the Western participants, this relationship was less consistent in the Sudanese group. Specifically, the Western participants were more likely to make their aesthetic choices and spend more time viewing paintings they preferred (see data for paintings Nos 65, 68N, 18, and 46). In contrast, this pattern was not observed with the Sudanese viewers. Given these differences, we will now explore the extent to which viewing time mediates the relationship between cultural background and aesthetic choice.

### MEDIATION ANALYSES

Mediation analyses were performed using the mediation package (v. 4.5.0; Tingley et al. 2022) in R (v. 2023.12.1.402; RStudio Team 2022). This method assesses the significance of the predictor's (cultural background: Western or Sudanese participants) indirect effect on the outcome (aesthetic choice) via the mediating variable (viewing time; Hayes 2018). We selected the aesthetic choice as a measure of viewers' preference decisions following the methodological framework established by Francuz (2013: 272–273; 277–278; see also Orquin and Mueller Loose 2013).

Full mediation is present when the indirect effect is significant, while the direct effect is not. Partial mediation occurs when both effects are significant. The mediation models tested are presented in [Fig. 5] below. Relationships between cultural background, viewing time and aesthetic choices were evaluated using a bootstrap mediation analysis, which generated bias-corrected 95% confidence intervals for the mediator's indirect effect based on 5000 bootstrap samples [see Fig. 5].

**Total viewing time to the whole painting.** The direct effect of cultural background on aesthetic choice was significant ( $b=0.72$ ,  $SE=0.07$ ,  $z=8.45$ ,  $p < .001$ ), suggesting that the Western participants made a greater number of aesthetic choices compared to the Sudanese participants. The indirect effects of Western and Sudanese cultural backgrounds

1 The eye-tracking data used in the analysis are available at <https://osf.io/u8qzv/>, DOI: 10.17605/OSF.IO/U8QZV (accessed: 28.05.2025).

were significant ( $b=0.014$ , 95% CI (0.004, 0.03),  $p=0.002$ ;  $b=0.008$ , 95% CI (0.002, 0.02),  $p=0.002$ , respectively). Additionally, the proportion of the effect that is mediated was higher in the Western than in the Sudanese group ( $b=0.10$ , 95% CI (0.03, 0.19),  $p=0.002$ ;  $b=0.06$ , 95% CI (0.02, 0.13),  $p=0.002$ , respectively). The proportion of the effect of cultural background on aesthetic choice that is medi-

ated through total viewing time for the Sudanese was 6.15%, and for the Western participants 9.82%. These results suggest that total viewing time partly (and in a small amount) mediates the effect of cultural background on aesthetic choice, with a stronger mediating effect observed among the Western compared to the Sudanese participants. We will now explore whether the effect of cultural background

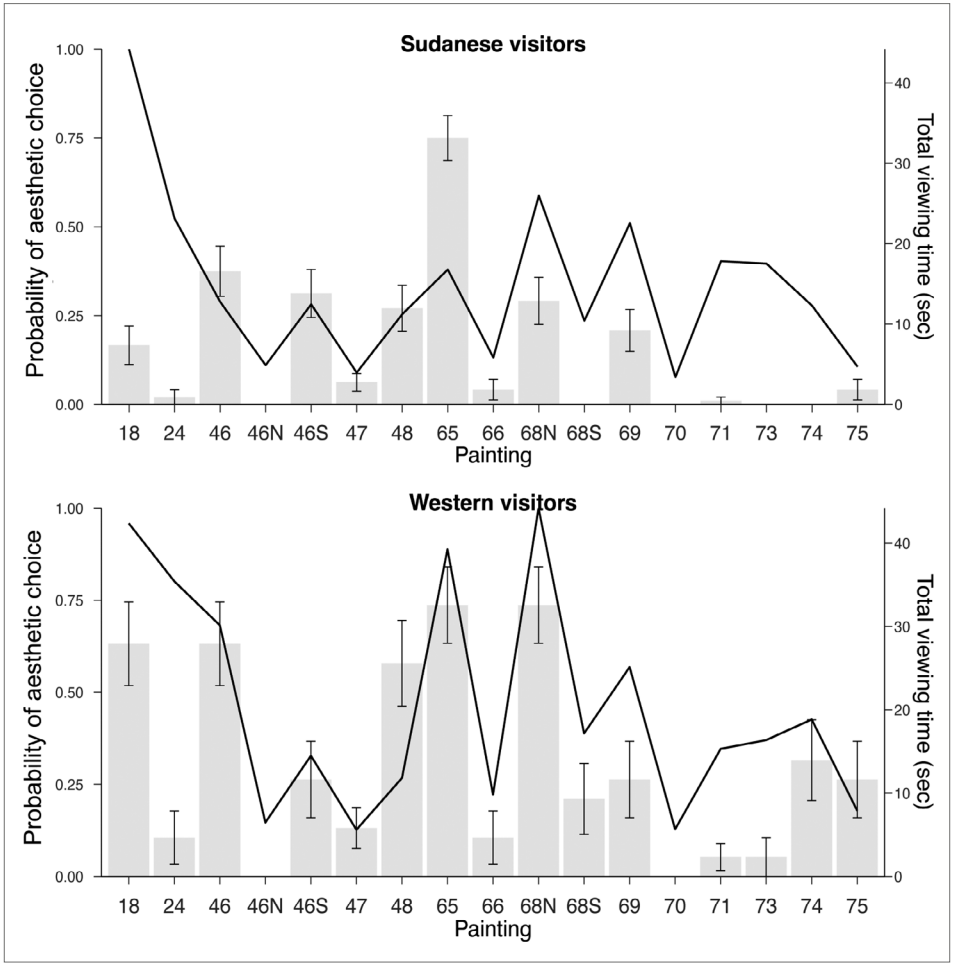


Fig. 4. Probability of aesthetic choice (indicated by bars) for Sudanese (top panel) and Western (bottom panel) participants across all paintings, mapped against total viewing time (indicated by solid lines). Error bars represent standard errors (SE) (Processing T. Trawiński)

on aesthetic choice is mediated by an increased time spent looking at faces or other areas of the painting.

**Total viewing time to faces in the painting.** For the model in which the total viewing time to faces was used as a mediator, we included 14 (out of 17) paintings, as only these contained faces. The direct effect of cultural background on aesthetic choice was significant ( $b=0.71$ ,  $SE=0.17$ ,  $z=4.16$ ,  $p < .001$ ) indicating that there was a higher frequency of aesthetic choices made by the Western participants compared to those made by the Sudanese participants. The indirect effects of both Western and Sudanese cultural backgrounds were also significant ( $b=0.03$ , 95% CI (0.01, 0.04),  $p < 0.002$ ;  $b=0.02$ , 95% CI (0.01, 0.03),  $p < 0.001$ , respectively). The proportion of the effect mediated was higher in the Western group than in the Sudanese group, suggesting a greater dependence on the mediator in the Western cultural context ( $b=0.17$ , 95% CI (0.08, 0.31),  $p < 0.001$ ;  $b=0.12$ , 95% CI (0.05, 0.26),  $p < 0.001$ , respectively). Furthermore, the

proportion of the effect of cultural background on aesthetic choice that is mediated through total viewing time to faces for the Sudanese was 12.71% and for the Western participants — 17.12%. Given the relatively small proportion of the total effect accounted for by the indirect effect, when considering the total viewing time of the entire painting, these findings indicate an important dependence on facial information in the process of aesthetic decisions.

**Total viewing time to areas beyond faces.** The direct effect of cultural background on aesthetic choice was again significant ( $b=0.75$ ,  $SE=0.10$ ,  $z=7.45$ ,  $p < .001$ ). The Western participants made more aesthetic choices than the Sudanese participants. The indirect effects for both Western and Sudanese cultural backgrounds were also significant ( $b=0.013$ , 95% CI (0.007, 0.02),  $p < 0.001$ ;  $b=0.009$ , 95% CI (0.004, 0.01),  $p < 0.001$ , respectively). Moreover, the proportion of the effect mediated was greater in the Western group compared to the Sudanese group, suggesting a stronger reliance on the mediator among the Western participants ( $b=0.09$ , 95% CI (0.05, 0.15),  $p=0.002$ ;  $b=0.06$ , 95% CI (0.03, 0.10),  $p < 0.001$ ). Nevertheless, the proportion of the effect of cultural background on aesthetic choice that is mediated through total viewing time to areas beyond faces was small: 6.11% for the Sudanese and 9.13% for the Western participants.

Finally, we compared the average proportion of the mediated effect across three mediation models. The results indicate that the model incorporating total viewing time to faces explains the largest proportion of the mediated effect (faces:

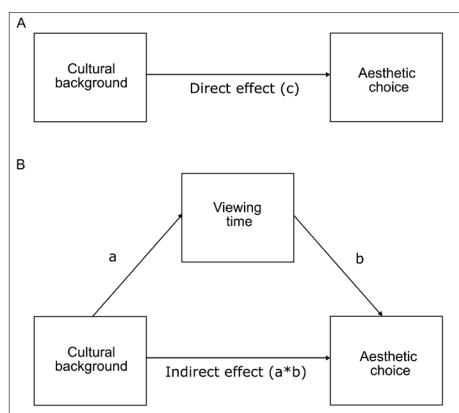


Fig. 5. Conceptual diagram of direct (A) and indirect effects (B) in the mediation model (Processing T. Michalik)

$b=0.12$ , 95% CI (0.05, 0.26),  $p < 0.001$ ; area beyond faces:  $b=0.08$ , 95% CI (0.04, 0.12),  $p < 0.001$ ; entire painting:  $b=0.10$ , 95% CI (0.07, 0.15),  $p < 0.001$ ). This suggests that

the duration of participants' focus on faces had the greatest impact on how cultural background influenced their aesthetic choices.

## DISCUSSION

In the present study, we explored how viewing time of Christian Nubian wall paintings mediates aesthetic choices in Western and Sudanese cultural groups. We assumed that viewers from various cultural backgrounds might visually engage with wall paintings in different ways, which, in turn, may influence their aesthetic experiences. Using a series of mediation models, we tested whether such relationships exist and explored how viewing specific parts of the paintings—faces or areas beyond faces—mediates aesthetic choices among participants from diverse cultural groups.

The analyses demonstrated that the viewing time partially mediated aesthetic choices in both groups. Moreover, we found that participants from both groups tended to base their aesthetic choices on a focus on faces. Our results also suggest that the viewing time had a stronger impact on aesthetic choices in the Western group, indicating potential differences in how the Western and Sudanese viewers built their aesthetic experiences. This indicates that cultural background, to some extent, influences how viewers visually engage with wall paintings, which, in turn, shapes their aesthetic choices. It also suggests that analyzing viewing behavior by eye-tracking may be a valuable method for understanding the aesthetic experiences of diverse stakeholders of archeological sites.

Contrary to our predictions, no evidence that viewing time fully mediates the effect of cultural background on aesthetic choice was found. One potential explanation for this partial mediation is that factors other than cultural background might also influence viewing time and aesthetic choices. As noted by Palumbo and colleagues (2025), the influence of viewers' openness to experience and a need for cognitive closure on aesthetic experience may be mediated by viewing time. For example, higher openness to experience fosters a greater curiosity and explorative behavior (including longer viewing time), which may, in turn, lead to a higher appreciation of ambiguous art, such as abstract art. Although Christian medieval Nubian wall paintings are figurative, the viewing time and aesthetic appreciation may be influenced by a viewer's personality alongside their cultural background.

Knowledge is another factor that might co-influence the viewing time. As suggested by the visuo-cognitive literature, experts differ from non-experts in their viewing behavior and aesthetic choices. Specifically, experts compared to non-experts take longer to look at structural and compositional elements of paintings and base their aesthetic evaluations more on these elements (Vogt and Magnussen 2007; Pihko et al. 2011). Furthermore, Harland and colleagues (2014)

demonstrated in their study that visual exploration of paintings is spatially and temporally limited for both experts and non-experts. However, they found that this exploration is directly linked to the verbal description of the painting and varies as a function of the task in both groups. Given that some participants were members of an archaeological mission, it is important to acknowledge that their prior knowledge may have influenced their viewing patterns and aesthetic choices. However, all Western participants had relatively higher familiarity with the subject matter of the paintings, as they depicted Christian motifs. Consequently, we expected a higher level of knowledge on this topic in the Western group compared to the Sudanese group. This highlights a challenge inherent in cross-cultural studies, which could be addressed by conducting fully balanced lab-based experiments where participants are asked to view paintings pertaining or not to their cultural backgrounds (e.g., Trawiński, Zang et al. 2024). However, given the naturalistic setting of our study, such an approach was not feasible.

Moreover, most studies on art appreciation to date have focused on paintings from the Renaissance to the modern era. Little is known about how viewers aesthetically engage with pre-Renaissance art. Research by Ho, Szubielska, and Kopiś-Posiej (2023) suggests that the historical period in which an artwork was created influences aesthetic appreciation. For example, contemporary art, compared to art of an earlier date, may be more challenging and less appreciated by some viewers. Yet it remains unclear

how visitors engage with wall paintings located *in situ*, whose style and form differ from post-Renaissance depictions. Whether the time when a painting was created impacts the level of visual engagement and the aesthetic experience is still to be determined.

Aside from the presence of factors that may co-influence the viewing time and aesthetic experience, we found that cultural background plays an important role in the exploration of particular aspects of paintings and in shaping aesthetic choices. Searching for elements of a painting that influenced the aesthetic choices to the largest extent, we found that for both groups the time spent on viewing faces was the strongest predictor of the participants' preferences. These results are congruent with research by Trawiński and colleagues (2021) on appreciation of portraits, which suggests that the time spent on viewing faces positively correlates with their aesthetic appreciation. Our findings are also consistent with research outside the context of art, which indicates the longer viewing time on faces is related to their greater appreciation (Maner et al. 2003; Leder et al. 2010; Leder, Mitrovic, and Goller 2016). Thus, to some extent, the Western and Sudanese viewers constructed their aesthetic experiences of Christian medieval Nubian paintings based on facial information in the paintings. However, we also found that for the Western participants the viewing time on faces had a stronger impact on aesthetic choices than it did for the Sudanese visitors. There are three possible ways to explain this difference.

Firstly, the longer time spent viewing

faces in the case of the Western viewers may be related to their greater familiarity with the themes presented in the wall paintings. Although we did not assign any specific task to the participants, we assumed that, while viewing the paintings, they would attempt to interpret the scenes depicted. One of the ways to understand the depicted scenes is through recognition of the depicted characters. Considering that the Western viewers were likely more familiar with biblical stories, as Christianity is culturally more present in Western societies than in contemporary Sudanese society, focusing on the figures' faces may have been an effective strategy for understanding the depicted scenes.

Secondly, a greater exposure to conventions of depicting biblical characters might enhance the aesthetic experience when viewing these paintings. As suggested by research in social psychology, exposure to a stimulus positively impacts its likeability (Zajonc 1968; Bornstein 1989). Research in aesthetics further suggests that this effect may extend not only to repeated stimuli but also to similar, previously unseen, stimuli (Zajonc 2001; Cutting 2003). Thus, a possible influence of the Western viewers' greater exposure to painting conventions in depicting holy figures in Christian art on their aesthetic experience cannot be excluded.

Thirdly, the artistic conventions used by Nubian artists, which aligned with cultural biases to engage viewers more with faces matching their own ethnicity (see Trawiński et al. 2023; Trawiński, Zang et al. 2024) may also have played a role. Martens-Czarnecka (2011) argues that skin color was an im-

portant means of artistic expression for medieval Nubian artists and the holy figures were depicted with a fair complexion, while local officials were depicted according to their actual appearance. In our stimulus set, most of the paintings (14 out of 17) depicted figures whose appearance was more congruent with the ethnicity of the Western rather than the Sudanese viewers. This may have encouraged the Western viewers to a prolonged viewing.

The differences in the impact of face viewing time on aesthetic choices may also result from the collectivistic nature of Sudanese society (Pelham et al. 2022). There is some evidence that viewers from collectivistic cultures process visual scenes differently than those from individualistic cultures (Chua, Bolland, and Nisbett 2005; Goh, Tan, and Park 2009; Duan, Wang, and Hong 2016; Šašinková et al. 2023). Given that faces are important to individuals' recognition, the lesser impact of viewing time on faces in shaping the aesthetic experience for the Sudanese visitors may result from their propensity for paying more attention to relationships between figures rather than the figures themselves. However, we did not observe a greater impact of viewing time on areas outside the faces on aesthetic choices among the Sudanese viewers, which could be expected given research on the influence of collectivism and individualism on visual processing. In both groups, the viewing time on areas outside the faces had the least impact on the participants' aesthetic choices. Furthermore, the viewing time on areas outside the faces had a stronger mediation effect

in the Western group. We suggest that the strong emphasis on visual exploration of the areas outside faces among the Western viewers may be related to their greater familiarity with and knowledge of Christian art.

To further investigate this issue, a direct comparison of viewing strategies between the Sudanese and Western viewers would be necessary. Differences with regard to focusing on faces have been reported by Michalik and colleagues (in preparation). We have not included detailed analyses here, as the primary focus of the present study is to examine the functional role of viewing time in aesthetic decision-making.

Given the potential limitations and directions for future work, we acknowledge that some of our results need future research. First, our stimuli set was limited to 17 paintings from four rooms of the Monastery on Kom H. Although the number of paintings we used is comparable to that in other eye-tracking studies in empirical aesthetics (Trawiński, Palumbo et al. 2024; Palumbo et al. 2025), it would be interesting to examine the aesthetic experiences of diverse visitors using a more varied set of paintings. An aspect that needs further exploration is the role of congruence between the appearance of figures depicted in wall paintings and the appearance of the viewers, and how it affects their viewing time and appreciation. In particular, it would be interesting to examine whether a larger set of paintings depicting local Nubian rulers would increase the viewing time of faces among the Sudanese group and influence their aesthetic choices.

The above results need to be regarded with caution due to the paintings' state of preservation. Since the paintings used in this study vary with regard to their preservation state, it may be interesting to test how this influences their aesthetic appreciation. Fontoura and colleagues (2023) reported that restored artworks encourage more explorative visual behavior (i.e. higher fixation count). Thus, finding out how the preservation state of paintings might influence viewing patterns and aesthetic appreciation could provide empirical evidence that may support conservation efforts.

Another aspect is the sample size. In the present study, we were interested in aesthetic appreciation among those who are stakeholders of the Old Dongola archaeological site. Thus, we focused on the local community, foreign tourists to the area, as well as members and collaborators of the archaeological mission. Although the sample was limited in number, still the impact of cultural background on viewing time and aesthetic appreciation could be identified; assumedly, a larger sample might allow to generalize our findings beyond the context of the stakeholders of the archaeological site.

Finally, we acknowledge the limitations of conducting research outside laboratory and art gallery settings. Research in uncontrolled environments involves reduced control over external factors such as weather conditions. However, our primary goal was to maintain high ecological validity, as we aimed to understand the aesthetic experience of visitors in the context of the place where the wall paintings were originally created.

## CONCLUSION

In this study, we investigated how viewing time mediates the relationship between viewers' cultural background and their aesthetic preferences when engaging with Christian medieval Nubian wall paintings. Using a series of mediation models, we found that viewing time partially mediated aesthetic choices of the Western and Sudanese viewers, with a stronger reliance on facial information in the Western group. Contrary to our predictions, the

viewing time did not fully mediate the effect of cultural background on aesthetic choices, indicating the influence of some additional factors. Nonetheless, our findings highlight the role of cultural context in shaping visual engagement with art and demonstrate the value of eye-tracking for understanding diverse aesthetic experiences, offering insights for the study of art perception and culturally inclusive heritage interpretation.

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**How to cite this article:** Michalik, T. and Trawiński, T. (2025). Impact of viewing time on aesthetic experience of Christian medieval Nubian wall paintings: an eye-tracking study with Sudanese and Western viewers. *Polish Archaeology in the Mediterranean*, 34.2, 161–180. <https://doi.org/10.37343/uw.2083-537X.pam34.2.5>

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