Aesthetic Appreciation and Spanish Art: Insights from Eye-Tracking

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Abstract

Eye-tracking – the process of capturing and measuring human eye movement – is becoming an increasingly prevalent tool in the cultural heritage sector to understand visual processing and audience behaviours. Yet most applications to date have focused on individual artworks and distinctions between representative/non-representative topics, with little prior work on the effects of differing written interpretations on the visual exploration of collections of artworks, particularly with devotional themes. This paper reports on an eye-tracking study that explored responses to the unique collection of Francisco de Zurbarán paintings in County Durham. Using eye-tracking technology in a laboratory setting, we evaluated the viewing behaviour of three participant groups to determine whether the accompanying written context influences how digital reproductions are experienced. In addition to demonstrating statistically significant variations in aesthetic appreciation, the experiments showed that the gaze can be redirected towards areas of conceptual significance. Most importantly, we were able to challenge the assumption that viewers always look at faces (Bindemann et al., 2005). Our findings make an important new contribution to the scholarly understanding of how audiences view, appreciate, and understand artworks, and to museum and heritage practices relevant to the display of art.

Introduction

How do people look at and experience artworks? On which elements do they focus? Do labels have an impact on the gaze? The experience of viewing art is complex, involving issues of perception, attention, memory, decision-making, affect, and emotion. Thus, knowledge of the time that users take and how they explore artefacts visually can provide information about user perceptions of relevance, interest, and aesthetic appeal.

This paper describes a collaborative project focusing on a unique collection of paintings produced by the Spanish artist, Francisco de Zurbarán (1598–1664). The cycle of *Jacob and his Twelve Sons*, which has been displayed in the Long Dining Room at Auckland Castle since 1756, is the only UK example of a continental collection preserved *in situ* in purpose-built surroundings. Towering over the heads of visitors, looking down imposingly upon them, the paintings have for centuries formulated an impression of monumentality, imposing the lessons of biblical history on the historical present. Of particular note is the strategic positioning of *Jacob* at the head over the table, where his identity would have merged in the mind of the observer with that of the Archbishop seated immediately beneath. Since some critics have also postulated a connection between Bishop Richard Trevor (1701–71), who acquired the artworks at auction, and his personal interest in promoting issues of religious tolerance, notably the repeal of the so-called Jew Bill of 1753, the paintings have also been noted for their implied political and ideological dimensions. The functional organization of the Long Room differs significantly in this sense from a contemporary gallery space, where artworks are more commonly presented to audiences in terms of their historical significance, artistic achievement, or aesthetic appeal.

While studies of the psychology of art have focused on individual compositions and distinctions between representative/non-representative approaches, no research has been undertaken on the aesthetic appreciation of thematically unified collections produced by the same artist or of the sequential elaboration of devotional themes, notably in the context of Counter-Reformation art,

where the practice of producing collections of designated groupings such apostles or virgin martyrs was commonplace, particularly in Spain.

In this paper, we report upon the insights eye-tracking techniques have provided into the unconscious processes of viewing. Since the purpose of the study was to assess the effects of different written interpretations on visual exploration, the paper reports on the study and discusses the potential impact of the techniques used on our understanding both of visual behaviours and museum/gallery practice. The project unites research strengths in Spanish art, experimental psychology, digital humanities, and museum/gallery studies to explore aesthetic reactions to digital representations of Zurbarán's paintings along with the significance of the collection as a whole.

Eye-tracking and Art

Our experience of art is a product of the interaction of several cognitive and affective processes, the first of which is a visual scan. When viewing an artwork, observers gather information through a series of fixations, interspersed by rapid eye movements known as saccades. The direction of saccades is determined by an interaction between the goals of the observer and the physical properties of the different elements of the scene (for example, colour, texture, brightness, and so on). Importantly, studying eye movements offers an insight, based on quantitative data, that does not depend on the beliefs, memories, or subjective impressions of participants. It has been widely used in Human Computer Interaction studies, where quantitative data is necessary to complement qualitative methods such as think-aloud protocols (Bergstrom & Schall, 2014). Previous eye-tracking research has highlighted the potential to transform how we understand visual processing in the arts (Bindemann et al., 2005; Massaro et al., 2012; Brieber et al., 2014), while also offering a direct way of studying museum/gallery visits (Milekic, 2010; Heidenreich & Turano, 2011; Filippini Fantoni et al., 2013; Walker et al., 2017).

Most recent research on the psychology of art has focused on secular and/or abstract rather than devotional and/or representational subjects, while the significance of conceptually unified collections has not, to date, been explored. The majority of eye-tracking studies have been conducted in the laboratory, using images of paintings on a digital screen. Even if this method provides full control over properties such as size, colour, and light, the task of the viewer and the eye-tracking methodology produce an experience that differs significantly from a gallery/museum visit. Several studies show that context can influence the overall aesthetic experience of artworks (Brieber et al., 2014; Blandford, Furniss, & Makri, 2016; Carbon, 2017). Rogers (2012, 73), discusses how studies conducted in a museum/gallery setting show how people come to understand and appropriate technologies in their own terms and for their own situated purposes. Studies of the link between art and aesthetic pleasure identify two different types of experience: viewers may enjoy art because it makes them feel happy, or because acquiring information about the artwork gives them intellectual satisfaction. Thus, a viewer may be pleased to learn that a painting is from Picasso's blue period, even if its subject feels intrinsically melancholy (Leder, Carbon, & Ripsas, 2006; Melcher & Bacci, 2013) . This article summarizes a controlled laboratory study. The next stage will be to evaluate differences between digital reproductions and physical artworks in museum/gallery settings, producing an understanding both of the distinctiveness of Spanish painting and how contemporary audiences can be encouraged to approach it.

Spanish Art in County Durham – Zurbarán

The cycle of *Jacob and his Twelve* Sons has been displayed at Auckland Castle since 1756, when it was brought to County Durham by Bishop Richard Trevor, who acquired it at auction (Pemán 1948; Finaldi 1994; McManners 2010; Baron & Beresford 2014). It has subsequently been studied on several occasions, and in the absence of commission documentation, the most romantic theory of origin holds that the works were seized by corsairs on the high seas and sold for profit. Each depicted on a separate

canvas and set against a low horizon, the thirteen figures make a powerful impression on the observer. Envisioned as distinctive individuals who do not interact or relate to one another physically or psychologically, they present a full spectrum of ages and social types, from a weather-beaten sailor to a king attired in magnificent royal regalia. Exploiting their arresting monumentality, Bishop Trevor refurnished and extended the Long Dining Room in their honour, positioning their feet at head height so they could tower imposingly over the observer. His only regret was that, since the paintings were individually priced, he was outbid for the final painting (the *Benjamin*, now at Grimsthorpe Castle, Peterborough), opting instead to complete the series with a copy by Arthur Pond (1705–58).

This study describes an application of eye-tracking technology to investigate the Zurbarán collection. It focuses on how audiences look at Spanish paintings, how aesthetic experience is evaluated, and whether audiences can be encouraged to approach art differently. As the first stage of a more extensive investigation of the extensive Spanish collections of County Durham, the study provides fresh insights into the potential of eye-tracking to transform how we understand visual processing in arts and cultures. It also analyses the factors important to a museum/gallery visit, and especially, the effect of label content on visual behaviour.

Method

The study sought to determine whether the accompanying written context, provided by museum/gallery labels, influences how digital artworks are experienced. We investigated whether contextual information impacts on where participants first look (first fixation), if gallery labels influence the time participants choose to view artworks, and especially, whether they influence aesthetic appreciation. Previous research signals the importance of considering the impact of viewing time on art perception (Smith & Smith, 2001; Carbon, 2017). We expected viewing time for artworks and corresponding labels to be predicted by the subjective experiences of participants, artwork related features, and contextual factors. Accordingly, we measured viewing time, fixation, and

saccades for each artwork and corresponding label using fixed eye-tracking technology (Tobii TX300) in a laboratory setting.[1]

Participants

Experiments took place at Durham University in June 2016. Forty-six students (15 males, aged 18–24, median 19.5) were recruited by posters displayed in locations around the University and from the Department of Psychology Participant Pool. This dual approach attracted volunteers from the Faculty of Arts and Humanities (mainly students studying degrees in Modern Languages and Cultures) as well from Psychology and other Social Science subjects. Curiously, despite the obvious relevance of the paintings to students studying Theology, no volunteers were recruited from that Department. All volunteers reported that they had normal or corrected vision and gave informed consent for the experiments. They had received no formal training and had no qualifications in Art History. They had also not previously visited Auckland Castle in order to make *in situ* inspections of the paintings. Volunteers from Psychology received course credit, while the remainder were paid £4/hr. The study was approved by the relevant Research Ethics Committee.

Stimuli and Apparatus

One third of participants were randomly assigned to the Museum Context group (nMC =16), which inspected digital images in conjunction with the contextualizing labels currently in use. These rely on relating individual compositions to the words of Jacob in Genesis 49, where he addresses each son in turn, often referring to the symbolic attributes used by Zurbarán in translating their experiences into pictorial form. One third of volunteers were assigned to the Aesthetic Context group (nAC = 15), which received labels foregrounding issues of aesthetic/interpretive interest, and the final third to the Attribution Only Context group (nAOC = 15), which received data outlining title, name and date of artist, date of composition, and nature of medium (for example, “oil on canvas”).

[1] http://www.tobiipro.com/product-listing/tobii-pro-tx300/

Contextualizing information

Previous research has shown that visitor interest in museum/gallery artefacts is generally diminished by labels that are "too wordy, too worthy or too woolly to do their job of communicating" (Mileham, 2006, 18). Thus, textual interpretation must synthesize and distribute information into smaller, more readable components. The existing labels, provided to the Museum Context group (MC), were written by the Church Commissioners prior to the establishment of the Auckland Castle Trust (see fig. 1). Conversely, labels for the Aesthetic Context group (AC) were produced by the authors on the basis of expertise in Spanish art and museum/gallery audience engagement. Their purpose was to provide participants with interpretive information, prioritizing aesthetic rather than theological considerations (see fig. 1).

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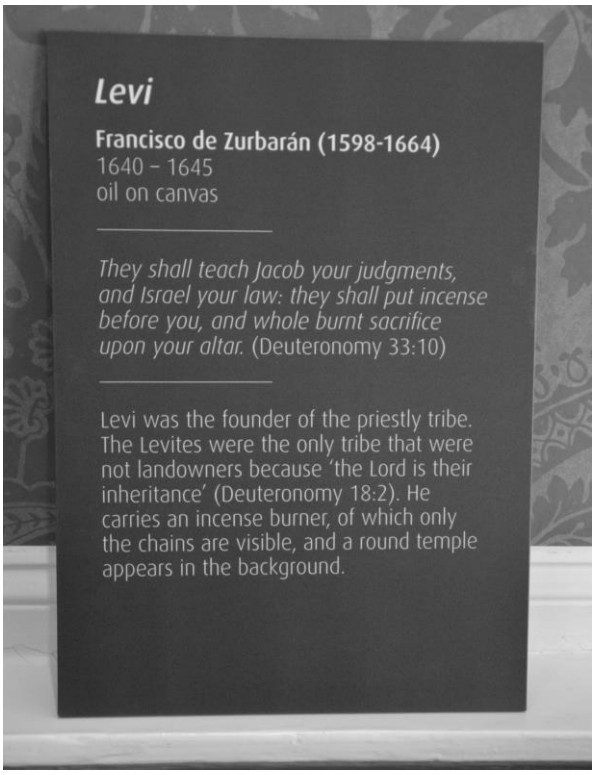
<td> 
</td>
<td>'Levi'

Standing with his back to the viewer and his head turned, Levi carries an incense burner by a golden chain. He is dressed in deep blue robes trimmed with tassels and golden embroidery, sporting a jewelled turban and a pair of boots luxuriously encrusted with pearls. In the background a small circular temple offers a timely reminder of his vocation as a Jewish priest.</td>
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<tr>
<td>MC label for Levi</td>
<td>AC label for Levi</td>
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Fig. 1: Example of MC and AC labels for 'Levi'

High-resolution digital reproductions of the 12 Zurbarán originals and Pond copy were presented in the same sequence for all participants (see fig. 2) on a 23" monitor with a refresh rate of 60Hz. The experiment was programmed using Tobii studio software. Manual responses were recorded with a mouse click, and eye-movements, with a Tobii TX300 eye-tracker sampling at 300Hz.

Fig. 2: 'Jacob and his Sons' as stimulus material. Francisco de Zurbarán (1598–1664), Jacob and his Twelve Sons, c. 1640–45, oil on canvas, Auckland Castle.

Procedure

Participants viewed the display with their head supported by a chinrest at a distance of 50cm. The experiment began with a 5-point calibration. Participants were presented with the context and given 10 seconds to read the text, but could press the SPACE bar on the keyboard if ready to view the image before the time had elapsed. After 10s/SPACE, contextual information was replaced by a fixation point. After 1500ms the fixation point was replaced by a digital reproduction of each of the 13

paintings. Participants were given 10s to view the painting and again told to press the SPACE bar if ready to proceed. On pressing the SPACE bar, they were presented with a Likert scale from 1–7 on which they were asked to rate their agreement with the statement “I enjoyed looking at this painting” by clicking a button (1 = completely agree / 7 = completely disagree). The next trial began with a new piece of contextual information. Each participant completed 13 trials (1 for each image), with paintings numbered 1–13 and displayed in this sequence for all participants. After completing the thirteenth trial they were presented with an array containing thumbnails of all 13 images and the question “One of these paintings is a copy. Which is it?” They were given 10s to explore the array, but could progress to the next response screen by pressing the SPACE bar. On the response page they clicked on the name of the painting they believed to be the copy. Participants were then presented with the array of 13 thumbnails with the question “Which of these paintings did you think was the most expensive?” They again had 10s exploration time, and when they had decided, they pressed SPACE, indicating their choice by clicking the relevant name. Fig. 3 illustrates this procedure. After completing the eye-tracking experiment, participants were asked to rank the paintings in order of preference.

Fig. 3: Illustration of the procedure during the experiment (the calibration phase is not shown)

Results

We filtered the eye-tracking data to exclude trials where blinks and loss of gaze tracking reduced data quality. This resulted in the rejection of >50% of trials in 5 participants. These participants were excluded from the analysis of the eye-movement, leaving a sample size of 41: Museum Context (MC=14), Aesthetic Context (AC=13), and Attribution Only Context (AOC=14). The data for the full 46 participants were included in the analysis of the questions about aesthetic appreciation, identifying the copy and estimation of value.

Regions of Interest

Previous research has shown that when paintings depict a human being, the viewer's gaze is focused predominantly on the human figure, independently of contextual elements also depicted in the image.

In particular, attention is given to the face, which plays a fundamental role in aesthetic judgement (Ro, Friggel, & Lavie, 2007; Massaro et al., 2012; Villani et al., 2015). Three key regions of interest (ROI) were therefore identified: the head, the clothes, and the props (elements of symbolic importance such as Judah's lion or Reuben's pillar). Saccades and fixations were identified offline in Tobii Studio using the default algorithm (onset criterion of 70 degrees/second and a minimum dwell time of 80ms). The key variables of interest for each ROI were (1) frequency of first fixation, (2) time to first fixation, and (3) total fixation duration.

Location of First Fixation

We first looked at the landing position of the first saccadic eye-movement. Fig. 4 shows the proportion of first fixations in the head, clothes, and prop ROIs or a location outside. The pattern is similar in all three context conditions, with the majority of first fixations on the face, fewer on the clothes, and fewest on the prop. Almost none fell outside.

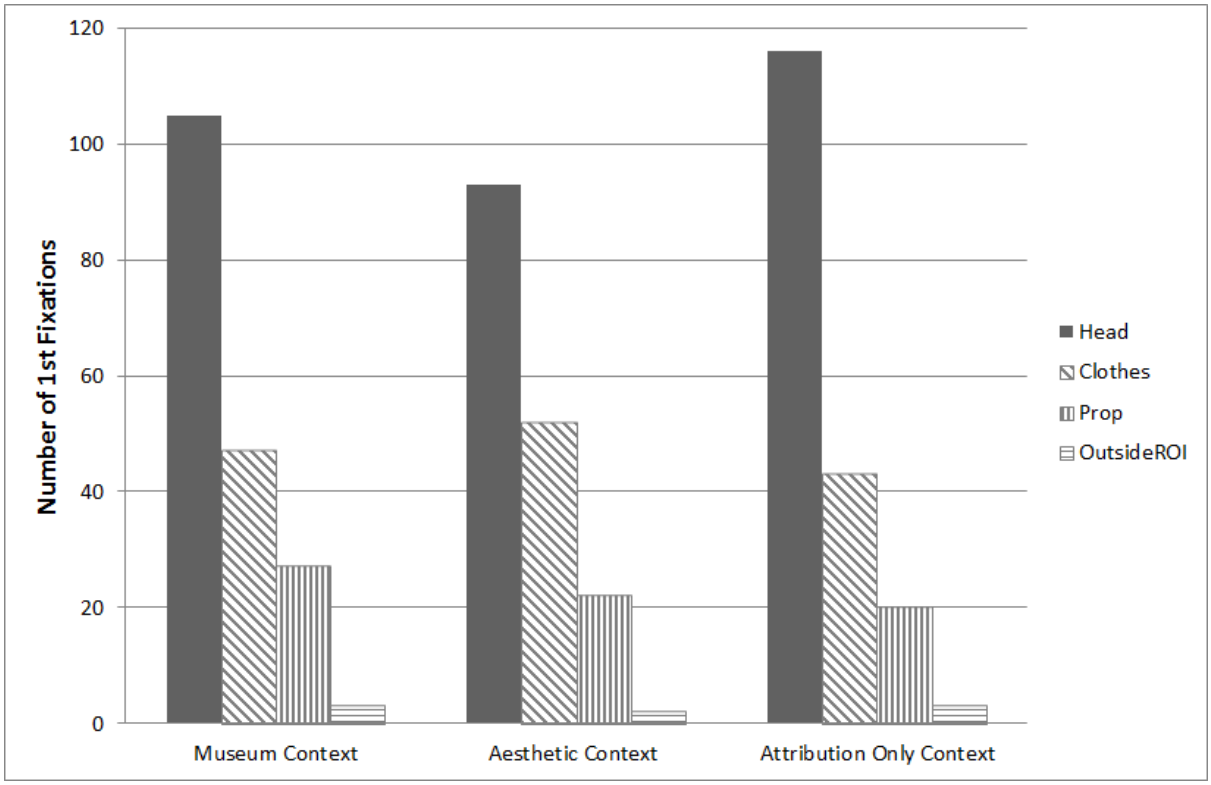


Fig. 4: Probability of the first fixations landing in the different ROIs

Time to First Fixation

We then examined the median time to first fixation for each of the ROIs. For this analysis we used Analysis of Variance (ANOVA) and t-tests to examine whether the manipulation of context led to statistically significant changes in eye-movement behaviour. Times are expressed as milliseconds (ms). By convention, p (probability) values of less than 0.05 are considered "significant", and allow us to reject the null hypothesis that there is no difference between the groups. Figure 5 shows that participants were slowest to fixate on the prop in all conditions. There is also a suggestion that participants fixated the head faster than the clothes in the MC and AOC groups, but not in the AC group. Repeated measures ANOVA revealed a main effect of ROI ($F_{(2)}$ =23, $p<0.05$) such that time to first fixation on the head occurred significantly earlier than first fixation on the clothes (657ms vs 1318ms; $t_{(40)}$ = 2.4, $p<0.05$) and prop (657ms vs 3652ms; $t_{(40)}$ = 6.2, $p<0.05$). The first fixation on the clothes also occurred significantly earlier than the first fixation on the prop (1318 vs 3652; $t_{(40)}$ = 4.2, $p<0.05$). There were no other main effects or interactions.

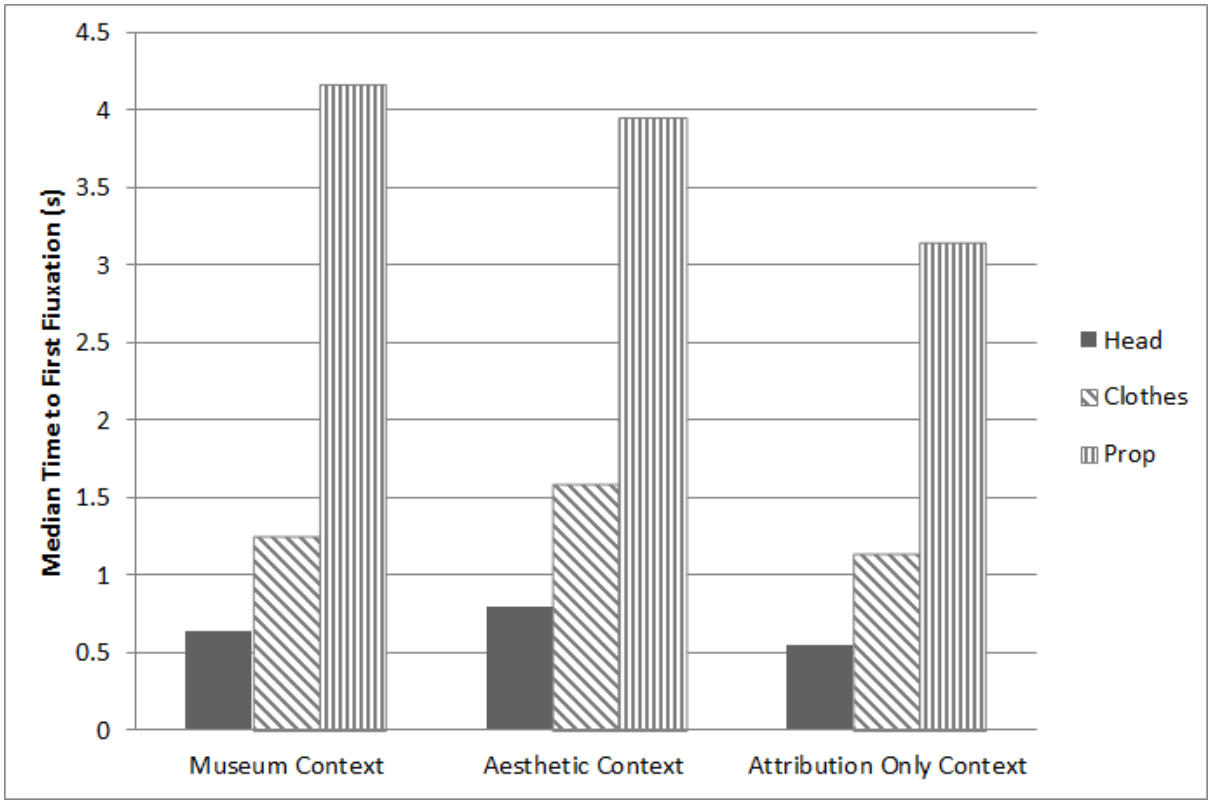


Fig. 5: Median time of the first fixations landing in the different ROIs

Total Fixation Duration

ROIs are of different sizes and shapes in the thirteen paintings. We therefore normalized fixation durations by calculating the percentage of total exploration time spent in each ROI for each painting. We then took the median value for each condition for each participant. These values were subject to a 3 x 3 mixed ANOVA with a within-subjects factor of ROI (head, clothes, prop) and a between-subjects factor of Context (MC, AC, and AOC). The analysis revealed a significant main effect of ROI ($F(2) = 94$, $p<0.05$) and an ROI x Context interaction ($F_{(2,4)} = 3.14$, $p < 0.05$). Fig. 6 suggests the interaction is caused by significant changes in the proportion of time spent in the head and clothes ROIs in the AC group compared to the MC and AOC groups. One-way ANOVAs confirm these impressions, revealing a significant effect of Context on the proportion of time spent in the head ROI ($F_{(2,40)} = 3.43$, $p<0.05$) and the clothes ROI ($F_{(2,40)} = 3.36$, $p<0.05$).

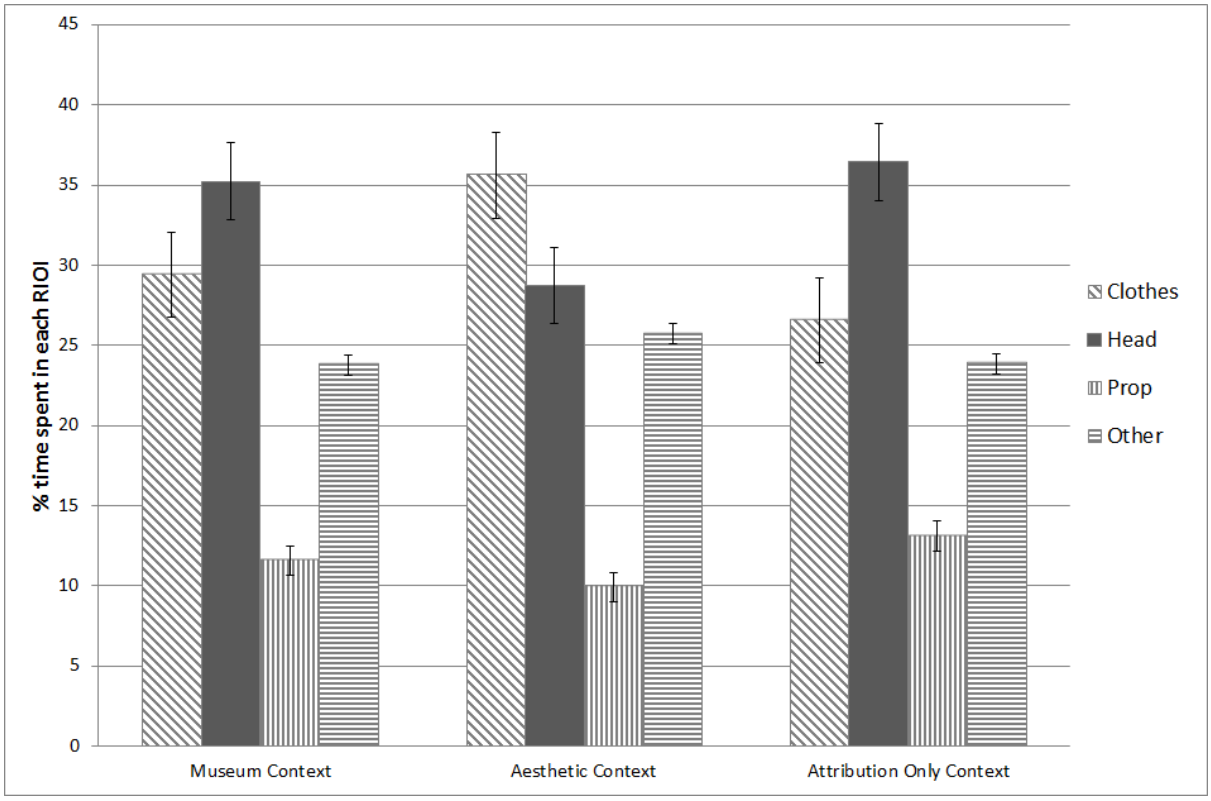


Fig. 6. Percentage of time spent fixating in each ROI. Error bars show +/-1 standard error of the mean.

When comparing first fixation data across the three participant groups (MC, AC, and AOC), the trend (fig. 4) suggests that contextual labelling changes the proportion of participants fixating on the face. The AC labels succeeded in dispersing the gaze more effectively than the current MC labels. In all thirteen paintings, the visual behaviour of participants changed in response to the written interpretation. This suggests that an AC labelling approach is more successful in stimulating and/or training the gaze than one rooted in theological extrapolation.

To visualize the viewing patterns of participants, we generated separate heat maps for each painting and each context group. The heat maps reflect which areas of each painting the participants fixated, and takes the number of fixations and their duration into account. Areas fixated more frequently and/or for a longer duration appear in red, scaling down to yellow and then green for regions fixated less frequently and/or for shorter periods (fig. 7).

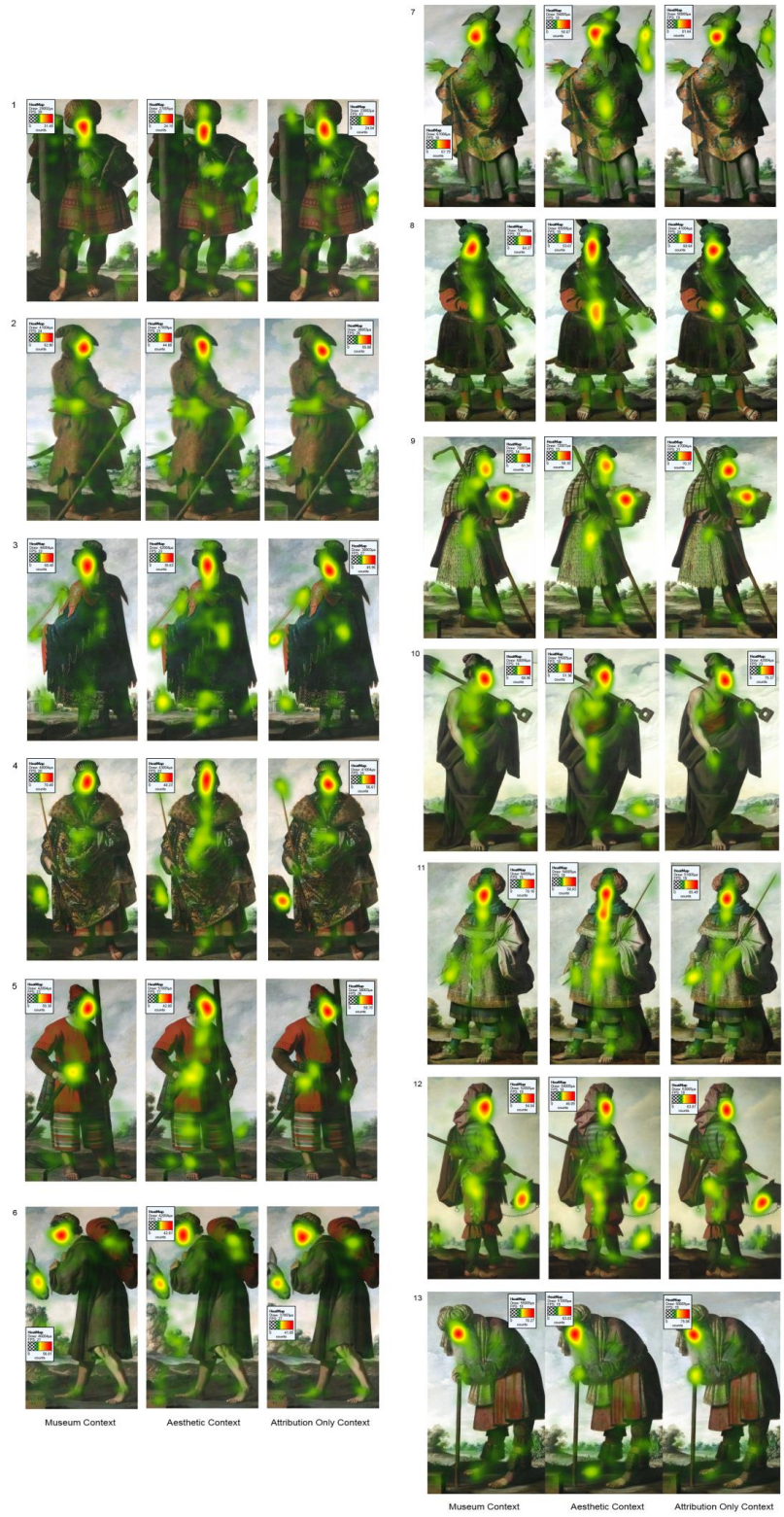


Figure 7: Heatmaps showing the distribution of gaze across each artwork in the three context conditions. The leftmost image shows the Museum context, the centre image shows the Aesthetic context, and the rightmost image shows the Attribution only context.

The results of the analysis of total fixation durations illustrate the tendency of participants to fixate on the head ROI more frequently and/or for a longer duration in the MC and AOC groups compared to the AC group. Overall, irrespective of the specifics of labelling information, participants intuitively make contact with faces. This finding corroborates published research in experimental psychology and art, which makes much of face recognition (Bindemann et al., 2005). Likewise, heat maps reveal that the AC labels disperse the gaze of participants more effectively than those of the MC group. In all thirteen paintings, participants fixated on a greater number of features, engaging in particular with the lower sections of the paintings and the prop ROI. In some instances, notably *Issachar*, *Dan*, *Gad*, and *Naphtali*, the developments were relatively slight and could potentially be dismissed as insignificant. Yet in others, especially *Simeon*, *Levi*, *Zebulun*, and *Joseph*, participants demonstrated a greater level of fixations across the paintings. This confirms that an aesthetic/interpretative approach is more successful in stimulating and/or training the gaze than one that remains rooted in theological extrapolation. For example, in the heat maps for *Levi*, some specific fixation points can be traced to details mentioned in the AC label, cited above (fig. 1). Of particular note are four points of detail: (1) "carries an incense burner by a golden chain", (2) "robes trimmed with tassels and golden embroidery", (3) "a pair of boots luxuriously encrusted with pearls", and (4) "a small circular temple offers a timely reminder of his vocation as a Jewish priest". These developments can be seen most clearly when the heat maps are arranged in parallel (fig. 8):

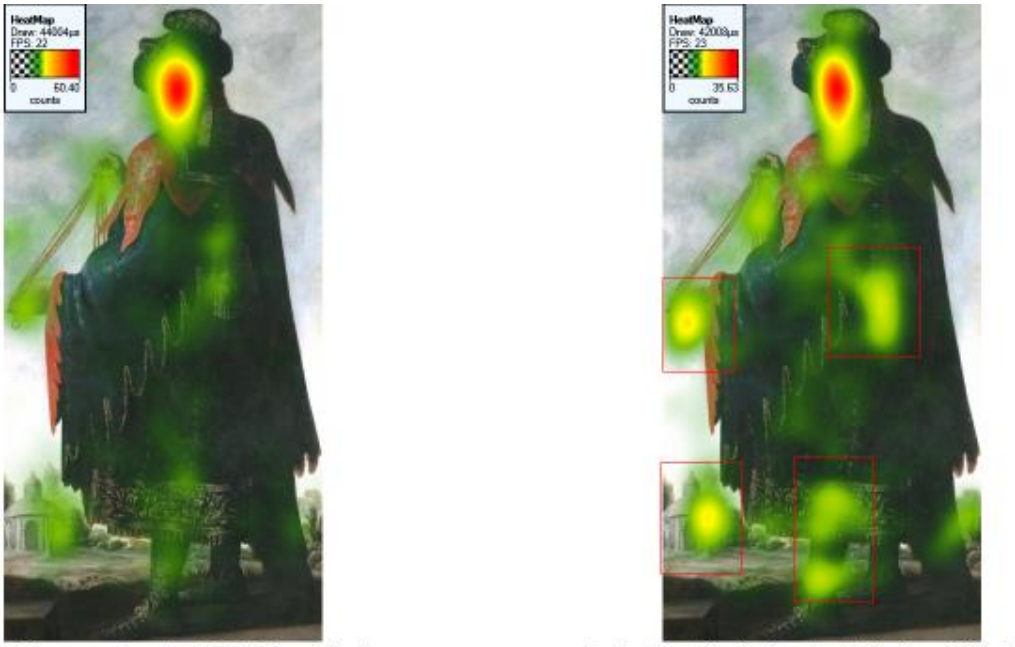


Fig. 8: Heat map visualization of gaze behaviour: In the image on the left, which displays the effect of the MC label, the gaze is not widely distributed. Conversely, in the image on the right, the gaze has been redirected towards areas of aesthetic/interpretive interest.

In contrast, heat maps for the AOC group demonstrate that the gaze lingers on areas which have either aroused curiosity or caused confusion. For example, the viewing patterns for *Judah* reveal that his lion produced a significant increment in interest, suggesting that participants were eager to obtain explanations for some of the more esoteric aspects of composition. Alternatively, interest could also be attributed to the fact that the lion has a face, which, although not human, functions nonetheless as an instinctive focus for audience recognition (Bindemann et al., 2005). The second significant finding is that Zurbarán's method of identification (the names and Roman numerals painted as sculpted inscriptions on the stone blocks in the foreground) was ignored or overlooked by all three participant groups. Although volunteers who received the AC and AOC labels displayed some interest in relation to *Reuben* (fig. 9), the first of the sequence, their attention waned on inspecting subsequent paintings, where series information was evidently considered less important or interesting than more vibrant and vivid qualities such as the depiction of faces, props, and clothing. This finding questions

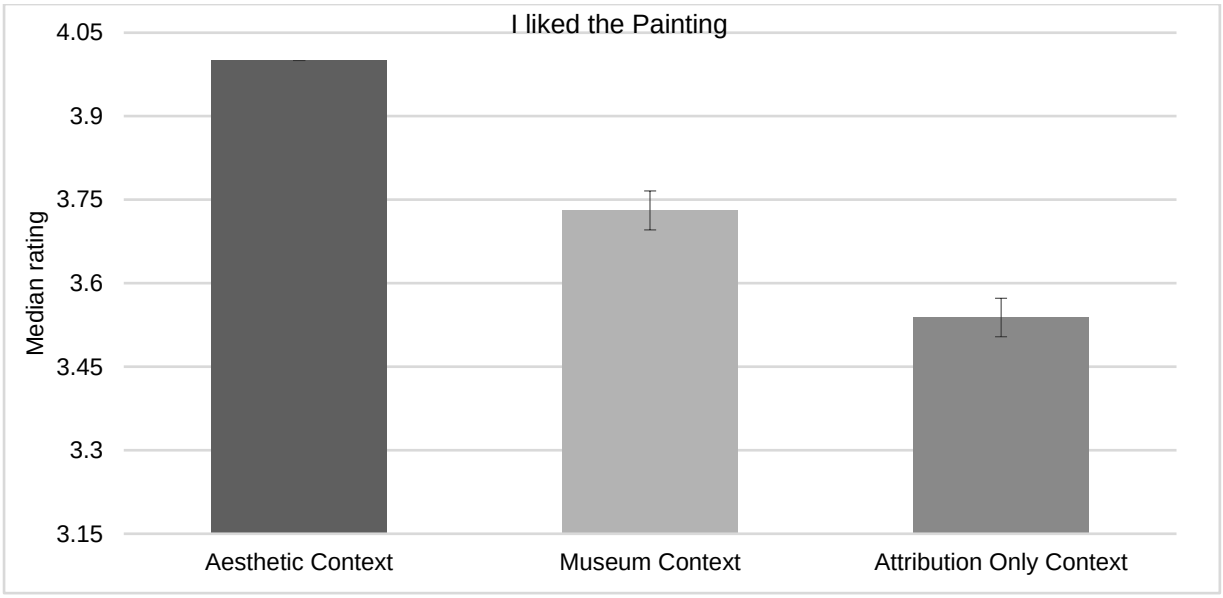
the effectiveness and relevance of Zurbarán's numbering technique, revealing that contemporary viewers have little interest in – or understanding of – the order in which the twelve sons are referred to sequentially by their father in Genesis, and thus, by Zurbarán in his paintings. It also has implications for work with mobile eye-tracking technology in gallery settings, questioning how, if not sequentially, audiences should be encouraged to approach ordered cycles of paintings through the development of contextualizing information. A particular issue in this respect is that, rather than enter the Long Dining Room by immediately facing *Reuben*, the eldest son, the current entrance obliges viewers to focus initially on the three final paintings in the series: *Naphtali*, *Joseph*, and *Benjamin*.

Fig 9: Heat map visualisation of gaze behaviour for *Ruben* (Left to right: Museum, Aesthetic, and Attribution only contexts)

Contextualizing Labels and Aesthetic Appreciation

Contextual museum labelling significantly influences levels of aesthetic appreciation and how the gaze can be trained and/or manipulated to engage with areas of interest that might otherwise be

overlooked. To evaluate how the different contextual museum labels affected enjoyment of the paintings participants were asked to rate each artwork they had just viewed on a 7 point Likert scale, posing the question "How much do you like this painting?" (1 = completely agree / 7 = completely disagree). The higher the rating, the less the participant liked the artwork. Fig. 10 displays the means of the median ratings in the three groups (MC, AC, and AOC), collapsed across paintings. Studies of viewing art in a physical context suggest that acquiring new information is positively correlated with intellectual mastery and enjoyment (Leder, Carbon, & Ripsas, 2006; Melcher & Bacci, 2013). Thus our hypothesis was that if the viewers were given additional information about the painting, and thus their attention could be drawn to different features, it could result in higher levels of interest and/or aesthetic enjoyment. Yet the opposite appears to be true: AC labels led participants to look less at faces (figure 6), which was associated with finding the experience less enjoyable (see figure 10). More specifically, participants liked the paintings significantly more (P=0.007) in the AOC group, where they had to form their own spontaneous judgements. The comparison between MC and AC labels showed the same pattern but do did not reach statistical significance (P=.08). It therefore appears that there is a contradiction between the emotional enjoyment of a painting and the cognitive effort of identifying features mentioned in contextualizing information when digital surrogates are viewed. This contradicts evidence from studies of physical art, so it is possible that the fact of digital reproduction itself is significant. This topic will require further and more detailed scrutiny: it suggests that we should not assume that the pleasure the viewer feels is equivalent, in a digital setting, to that in a physical one. If these findings are replicated, they could have significant impact on museum/gallery practice, but also for displaying digital surrogates of art works, for example on gallery websites.



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329 Fig. 10: Aesthetic appreciation rating of the artworks by group. Error Bars show +/-1 SEM

330 ## *Auction Prices and Estimation of Value*

331 This paper will also discuss a how participants identify and rank artworks in terms of authenticity and
332 value. By ranking compositions, we will cross-reference attitudes with the prices paid by Bishop Trevor
333 at auction in 1756, considering how aesthetic tastes have changed.

334 The Zurbarán paintings were acquired individually at auction. Bishop Richard Trevor's receipt (see
335 Finaldi 1994), which only partially follows the order of the series, itemizes prices for eleven of the
336 thirteen paintings: *Jacob* (£8 15s), *Reuben* (£2 2s), *Simeon* (£7 7s), *Levi* (£5 5s), *Judah* (£6 6s), *Dan* (£6
337 6s), *Naphtali* (£21 10s 6d), *Gad* (£13 2s 6d), *Asher* (£15 4s 6d), *Issachar* (£21 10s 6d), and *Zebulun* (£16
338 16s). In addition to the auction costs (£124 5s), he paid £21 for the *Benjamin* copy, and £1 6s for
339 relining *Joseph* (Fig. 11). Unfortunately, no separate receipt for the auction price of *Joseph* has
340 survived.

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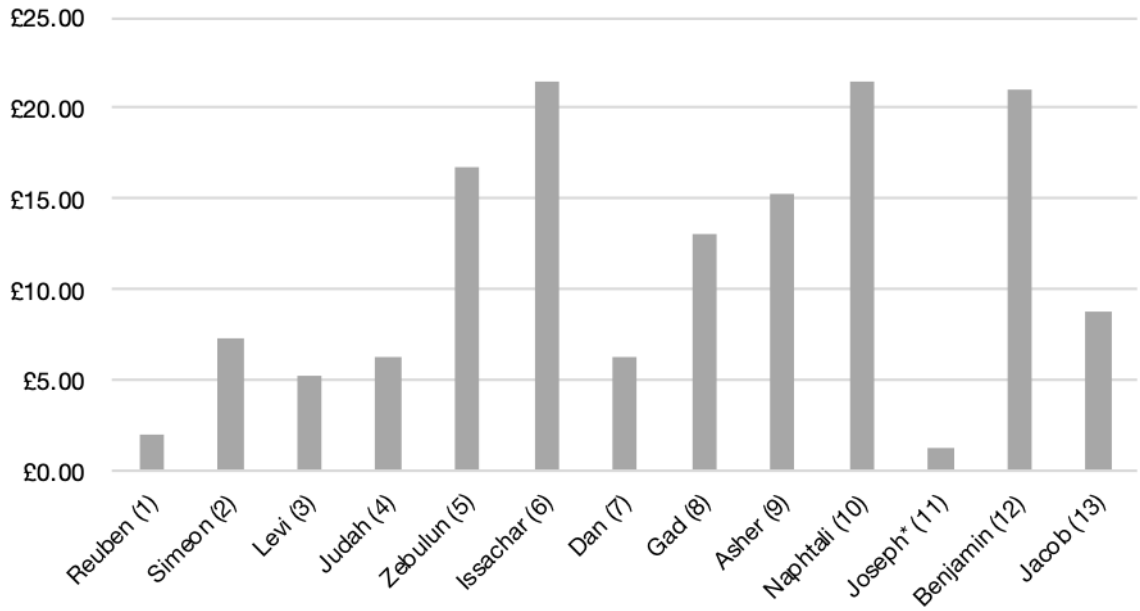

Fig. 11: Cost of paintings at the time of acquisition

In view of the pressures of the bidding process, the original price of the paintings cannot necessarily be regarded as an accurate measure of their financial value. It does, however, produce a ranking that can be cross-referenced with contemporary perceptions of economic value and aesthetic quality. We therefore asked participants which painting looked the most expensive, comparing their opinions both with the prices paid at auction and their own aesthetic judgements. We expected that this would provide information about the relationship between perceptions of value and aesthetic quality in both synchronic and diachronic terms.

Two MC labels offer clear statements on pricing: "With *Naphtali*, this was Bishop Trevor's most expensive purchase at just over £21" (*Issachar*) and "The artist charged him £21, almost as much as Trevor had paid for the most expensive original" (*Benjamin*). However, since none of the MC respondents identified *Issachar* or *Naphtali* as the most expensive, it is clear that this information did not influence their opinion. Their judgements were thus formed exclusively on individual aesthetic grounds.

Figures from the three groups (MC, AC, and AOC) show that not a single respondent regarded *Issachar* or *Naphtali* (both of which cost £21 10s 6d) as the most expensive. They can be grouped accordingly with *Simeon* and *Gad*, which were also rejected by all respondents. The eight other paintings received marginally more enthusiastic responses. *Reuben* and *Zebulun* were favoured by 1 respondent, *Levi* by 3, *Dan*, *Asher*, *Benjamin*, and *Jacob* by 4, and *Joseph* by 5. Most striking, however, is that 43% of volunteers regarded *Judah* as the most expensive (fig. 12). Notably, when participants were asked to rank the paintings in order of preference Jacob emerged as the most preferred, followed by Judah, Asher, Issachar, Joseph, Dan, Levi, Benjamin, Reuben, Zebulun, Napthtali, Gad, and Simeon.

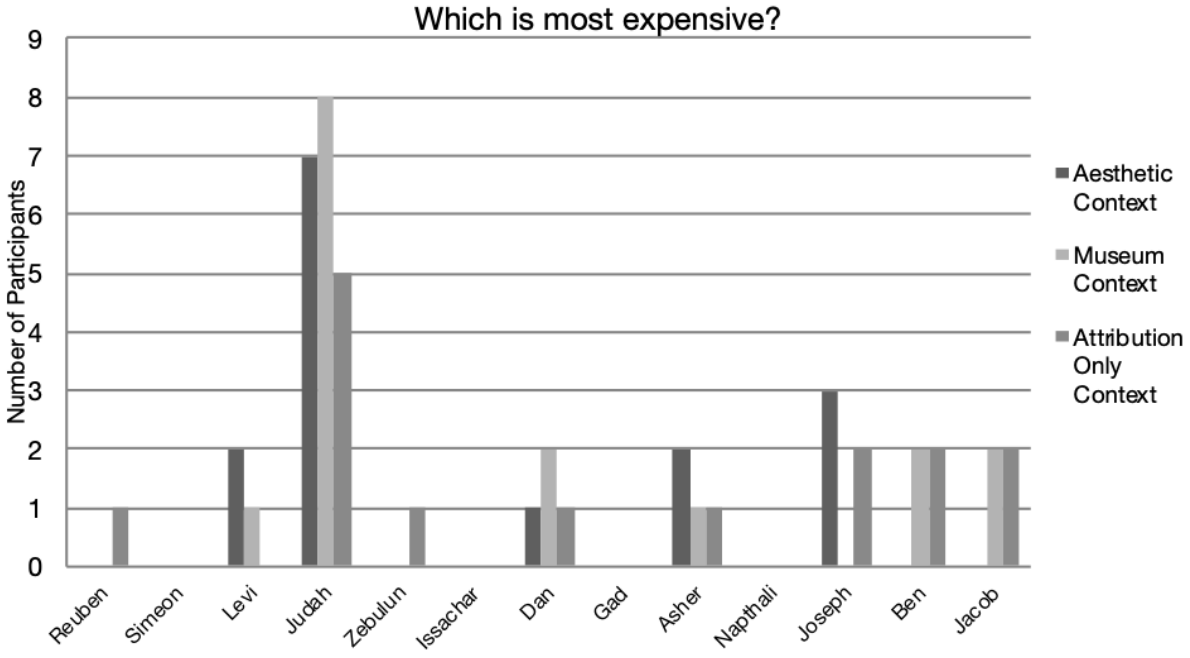

Fig. 12: Participant estimation of artwork financial value

A comparison of the three data-sets does not otherwise reveal significant divergences, except that the absence of contextualizing information appears to make volunteers marginally less certain of their judgement. While participants in the MC group nominated 6 paintings, and the AC group nominated 5, the AOC group spread their judgement over 8 paintings. This suggests that contextualizing information can have a significant impact on preempting and influencing impressions of financial value.

When participants scrutinized an image of the paintings arranged on a single screen (see fig. 13) heat maps revealed that their views were formed almost exclusively in relation to engagement with faces rather than garments or other aspects of composition. In almost every instance, no attention was paid to the lower portions of the paintings, demonstrating that judgements of aesthetic appreciation and financial value are formulated in the same way. Since this finding has not previously been discussed, the question of how respondents form judgements in relation to abstract and/or non-representational works that avoid the potential for face-bias is likely to yield further, more significant insights.

Fig. 13: Heat maps revealing how judgements of valuation and aesthetic appreciation fixate on the face. Panel 1 shows the Museum context, Panel 2 the Aesthetic Context, and Panel 3 shows the Attribution Only Context

Differences across the three data-sets are revealing. The gaze of AC group participants fixated almost exclusively on *Judah* and *Joseph*. This correlates with appraisals of financial value, with 47% favouring the former, and 20% the latter. Participants in the MC group fixated on a broader range, but concentrated most attention on the same two paintings. In this instance, 50% selected *Judah*, but not a single respondent selected *Joseph*, suggesting a process of cross-comparison followed by a conscious decision to nominate the former in preference to the latter. The fixation patterns of AOC group participants shifted considerably, with the emphasis of attention falling on *Joseph* and *Benjamin*. Although in this instance *Judah* did not receive significant scrutiny, a third of respondents still thought it was the most expensive.

The corollary is that volunteers appeared to experience a more robust psychological connection with *Judah*. It was highly prized in aesthetic terms and participants regarded it as the most financially valuable. Since the AOC group nominated it without subjecting it to detailed scrutiny, the logical inference is that factors innate in the painting equate to impressions of financial value in the mind of the contemporary observer. One explanation is the use of gold, which traditionally connotes wealth, opulence, and social status. However, the symbolic trappings of kingship, notably crown and sceptre may formulate an unconscious impression of monetary value. This seems compelling since the four least highly regarded paintings (*Simeon*, *Issachar*, *Gad*, and *Naphtali*) depict figures dressed in functional, rustic, or drab outdoor costumes. This interpretation is consistent with the psychology of decision-making: there is considerable evidence that people utilize heuristics to reduce the cognitive load of complex decision-making (Tversky & Kahneman, 1974), and such biases have been shown to affect valuations of art. For example, the effort heuristic (Kruger et al., 2004) describes a propensity to attribute greater worth if the viewer believes the artwork took more time to create. Although there is little in the paintings to signal distinctions in value, it remains plausible that non-expert participants derived cues from the visual “richness” of the painting (accepting implicit connotations of wealth and status) as a heuristic. This enabled them to reduce the cognitive load of decision-making in relation to a collection of unfamiliar and superficially similar paintings.

An additional consideration is the lion, which is appraised in folklore as the king of the beasts, and in the Christian tradition, as a symbol of the resurrected Christ. Drawing on the medieval bestiary, which avers that whelps are born dead but are after three days restored to life, the lion is a popular symbol of liminality, positioned often at entrances and on doorknockers. Tamed, in this instance, by Judah's authority, its presence intimates that the devout should bow before him, a factor translated unconsciously into appraisals of financial worth.

The associations implicit in *Judah*'s psychological impact are, however, traditional rather than contemporary, and since they are not reflected by the prices paid at auction, it becomes necessary to consider other factors. A significant consideration concerns whether participants were influenced by the fact that *Judah* is the only painting to depict a figure facing forward while making eye contact. Psychological research shows that direct gaze, even when depicted by a static photograph, is associated with better memory for the face of the person with whom the mutual gaze was shared (Mason et al., 2004). It also enhances the perception of emotions such as anger and joy (Adams & Kleck, 2005) while increasing the ability of viewers to self-report their physiological responses to a face accurately (Baltazar et al., 2014). These studies are consistent with the assumption that *Judah* elicited a unique psychological response from observers, which may have translated into an impression that it was of greater value.

Detecting the Copy

Since Bishop Trevor was outbid at auction, *Benjamin* is a copy by Arthur Pond. Basic attribution data given to the three groups identified the painting as a copy. We wanted to test whether participants could retain this information and identify the correct painting.

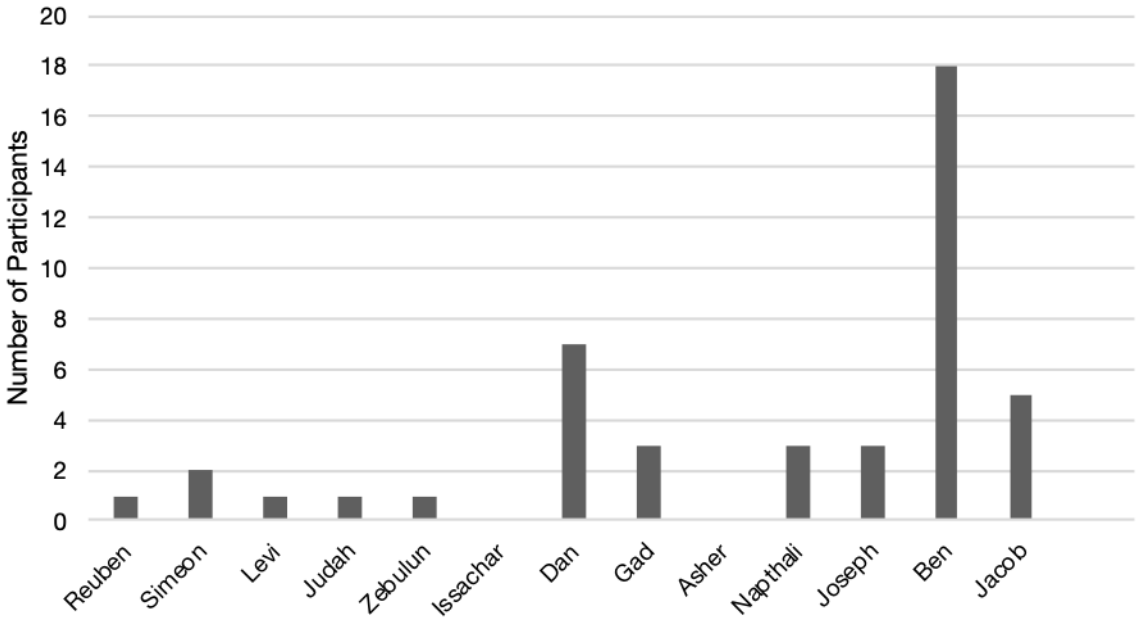

Fig. 14: Graph showing which artwork participants considered to be a copy

A global tabulation of results is surprising (fig. 14). Only 40% of respondents correctly identified *Benjamin* as a copy. Ten other paintings were identified as inauthentic, with only *Issachar* and *Asher* regarded as genuine. More surprisingly, AC group participants were largely unsuccessful at detecting the copy, despite the relevant information forming a crucial part of the accompanying interpretation (fig. 15). Participants in the AOC group fared considerably better, which may be attributable to the fact that working memory is limited to around 7 items, if participants are actively attempting to rehearse them (Miller, no date). This capacity is considerably reduced if participants simultaneously perform another task (for example see Baddeley, Thomson, & Buchanan 1975). In our study, contextual information exceeded the capacity of short-term memory in both the MC and AC groups, leading to forgetfulness and loss of information. However, in the AOC group there were only 5 pieces of information to retain, which is within the normal capacity of short-term memory. In this case, participants would have been more likely to encode the *Benjamin* attribution to Arthur Pond and recall the painting as inauthentic. Thus, the apparently paradoxical finding that participants given less information were more successful at advancing judgements of authenticity may be explained by a failure of short-term memory. Participants in the MC and AC groups may have been more likely to

forget attribution data when confronted by the demands of processing complex contextualizing information.

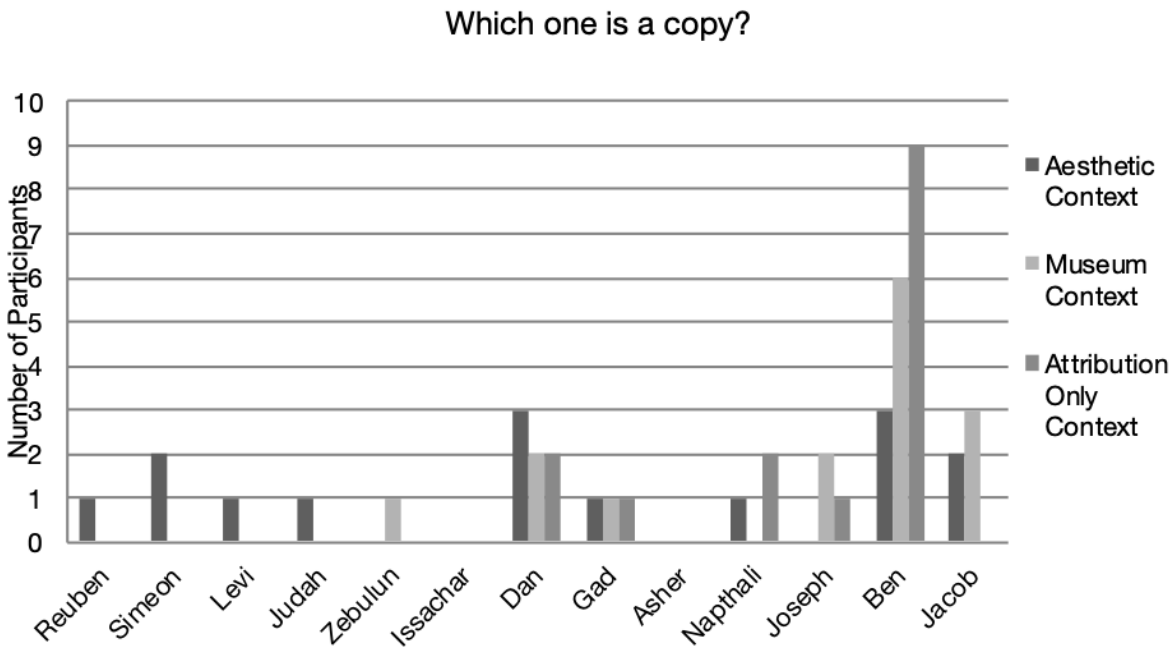

Fig.15: Context group breakdown of which artwork the participants considered to be a copy

Summary and Conclusions

Previous studies of museum/gallery visitor behaviour have primarily investigated how people respond behaviourally and cognitively to the design and layout of exhibits. However, they largely ignore the behavioural responses at the 'exhibit-face' (vom Lehn & Heath, 2006) or the 'fat moment'[2] (Garfinkel, 1967) of visitors' action. However, this paper has shown that the use of eye-tracking techniques can provide unprecedented insights into the unconscious viewing processes of the 'fat moment' of the unique collection of Zurbarán paintings. The use of quantitative data from fixations advances scholarly understanding of the process of viewing art. It provides a more robust picture of the process of viewing

[2] This is the moment when a visitor establishes an experience of an exhibit.

462 artworks, based on details of eye movement, than has previously been possible using self-reported
463 qualitative data, or observational studies.

464 For example, this study demonstrates that, due to the limits of working memory, users may struggle
465 to retain information about artworks, for example about value or authenticity, if provided with too
466 much detail. The impact of such a finding on gallery practice could be significant in terms of the volume
467 of contextual information that should be provided to visitors and the importance of repeating
468 information that users may require adequately to appreciate the artworks.

469 It also highlights statistically significant variations in levels of aesthetic appreciation, showing that
470 written interpretation can redirect the gaze towards areas of conceptual significance and away from
471 faces, thus challenging the assumption that face-bias traditionally plays a fundamental role in
472 aesthetic judgement. The consequences of this for aesthetic pleasure are, however, not
473 straightforward. Following the literature on studies of aesthetic appreciation of physical artworks, our
474 initial hypothesis was that users might find it interesting and therefore pleasant to be directed to look
475 at a wider range of features of the paintings. Yet the opposite proved true: they enjoyed the
476 experience less, if directed away from faces. Judgements of increased value were also negatively
477 correlated with pleasure.

478 Such findings represent a significant advance in our understanding of user behaviour when viewing
479 digital surrogates of physical objects or spaces and how this gives rise to emotional responses, an area
480 which is, as yet poorly understood. Recent studies suggest that different brain regions are activated
481 when, for example reading or writing in physical, as opposed to digital settings (Mangen & Velay, 2010;
482 Mangen, Walgermo, & Brønnick, 2013; Mueller & Oppenheimer, 2014). Users also appear to report
483 less emotional involvement with, or pleasure in, the use of digital surrogates and only experience
484 wonder or excitement when visiting physical cultural heritage sites (Cameron, 2007; Varnalis-Weigle,
485 2016). Our study found that in digital settings as opposed to physical ones, greater cognitive mastery

is not correlated with pleasure. This would, initially, appear to be consistent with this phenomenon. However, the implications of our findings are more complex.

We are not aware of any previous studies that link identifiable features of digital surrogates to aesthetic pleasure or enjoyment. However, our study shows that, if directed away from the face, a viewer's pleasure in the digital work decreases. Thus, by implication, viewing a face in a digital image *does* give rise to aesthetic pleasure. It becomes possible in this respect to identify a feature of a digital surrogate that is correlated to pleasure. This is an entirely innovative finding, and one that must be tested in further studies. We plan to do so by using digital images of still lives, landscapes, or images containing animal faces, and to use mobile eye trackers to investigate emotional responses to art in physical gallery settings in the next phase of our research. Nevertheless, for the first time, this study has provided quantitative evidence of a feature of a digital surrogate that can be shown to give rise to a positive emotional response, a topic about which no previous evidence exists. Our findings therefore make an important new contribution to the scholarly understanding of how audiences view, appreciate, and understand artworks, and to museum and heritage practices relevant to the display of art.

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