Reading between the lines: how visitor type and label design shape engagement with art in the museum

Pilz, Z.P.; Kret, M.E.; Helleman, T.; Simkonyte, G.; Wizke, S.; Broekgaarden, A.; ... ; Walker, F.

J Cult Cogn Sci
https://doi.org/10.1007/s41809-026-00203-2

RESEARCH PAPER

Reading between the lines: how visitor type and label design shape engagement with art in the museum

Zsofia Pilz · Mariska E. Kret · Tobias Helleman · Goda Simkonyte · Stefan Wizke · Annemies Broekgaarden · Pauline Kintz · Laurens van den Broek · Francesco Walker

Received: 9 February 2026 / Revised: 28 March 2026 / Accepted: 30 March 2026

Abstract Art museums welcome visitors with varying levels of prior knowledge, making interpretive tools such as labels essential for encouraging engagement and improving understanding. In partnership with the Rijksmuseum in Amsterdam, this study explored how visitors respond to Formal–Descriptive versus newly designed labels accompanying paintings that address the Dutch colonial past. Formal–Descriptive labels were designed to guide the visitors view, while the Contextual–Historical labels aimed to raise historical awareness by focusing on colonial histories and their implications. As visitors have different motivations for coming to the museum, we examined two visitor profiles: "Pleasure Seekers", who primarily visit for enjoyment and a visual experience, and "Art Lovers", who tend to seek deeper contextual or historical meaning. Using a mixed-methods approach including eye tracking, interviews, and self-report measures, we examined visual attention, emotional responses, and interpretation across three paintings. Pleasure Seekers showed larger pupil diameters and spent more time reading labels than Art Lovers, possibly reflecting greater cognitive effort. Viewers in the Contextual–Historical label condition spent more time initially engaging with label content and made fewer saccades, indicating more focused attention. Interviews revealed that Art Lovers used more historically specific language. Questionnaire data showed that Formal–Descriptive labels were linked to more negative reactions to sensitive topics. These findings demonstrate that museums can integrate historically sensitive narratives without causing discomfort and underscore the importance of tailoring interpretive texts to diverse audiences to support reflection and inclusivity.

Keywords Museum engagement · Label design · Museum education · Art interpretation · Museum visitors

Z. Pilz (✉) · M. E. Kret · T. Helleman · G. Simkonyte · S. Wizke · F. Walker
Leiden University, Leiden, The Netherlands
e-mail: z.p.pilz@fsw.leidenuniv.nl

Z. Pilz
EBS Universität for Business and Law, Oestrich-Winkel, Germany

A. Broekgaarden · P. Kintz
Rijksmuseum, Amsterdam, The Netherlands

L. van den Broek
Tobii AB, Stockholm, Sweden

Introduction

What shapes how we look at a painting? Art museums draw millions of visitors annually, representing individuals from diverse backgrounds with varying levels of art knowledge. Some visitors have contextual or stylistic knowledge of specific periods, while others

Published online: 06 April 2026

need additional information to fully engage with and appreciate an artwork. To address these needs, museums provide informative labels alongside paintings, typically 60 words in length (Kintz, 2024). Research suggests that visitors often rely on these labels for guidance (Castellotti et al., 2023; Lin & Yao, 2018; Reitstätter et al., 2022) and that information tailored to specific audiences, such as children, effectively directs attention to key elements within a painting (Walker et al., 2024). Despite this potential, interpretive labels are rarely adapted to the needs or levels of expertise of different visitor groups (Pilz et al., 2026). The ability to interpret and comprehend a painting has further been linked to an increased appreciation of aesthetics, suggesting that informed viewers gain deeper insight into artworks (Darda & Chatterjee, 2023; Leder et al., 2004; Skov & Kirk, 2022).

Interpreting a painting through its historical and cultural background is especially important when artworks reference colonialism, power, or violence. Such contextual knowledge enables viewers to interpret symbols, styles, and themes tied to specific events or movements (Sill, 1996). Without this framing important nuances may be overlooked, and the artwork's full meaning may remain inaccessible. This need for context becomes especially important when engaging with Dutch Golden Age paintings, many of which depict themes associated with the Dutch East India Company (VOC) and colonial expansion (Grijzenhout, 1999). Although this period was characterized by economic and cultural growth, it also entrenched colonial exploitation. Paintings from this era often contain subtle references to colonial trade, exotic goods or depictions of foreign individuals, elements that are often overlooked in traditional interpretations (Hochstrasser, 2007). Providing additional context through labels can highlight colonialism's role in shaping Dutch society and its production of art, encourage more critical engagement with these works.

In order to understand how contextual information affects viewer's perception, it is necessary to consider the cognitive processes that guide visual attention. At the core of this process are bottom-up and top-down mechanisms, which work together to shape how visual stimuli are processed. Bottom-up processes are stimulus-driven, prioritizing visually salient features such as color, contrast, or motion. Top-down processes, on the other hand, are influenced by the viewer's knowledge, expectations, and goals (Henderson & Hayes, 2017; Itti & Koch, 2000; Yarbus, 1967). In the museum context, labels can act as top-down cues, shaping how viewers explore a painting (Castellotti et al., 2023; Walker et al., 2017). Understanding the interplay between these attentional mechanisms helps explain how tools like labels influence not only where viewers look but also how they interpret what they see.

This interplay of bottom-up and top-down processes is further modulated by viewer expertise. Art experts tend to have more systematic and semantically guided viewing patterns, while novices rely more heavily on perceptual saliency (Pihko et al., 2011; Vogt & Magnussen, 2007). As a result, experts may depend less on descriptive labels, drawing instead on their own knowledge structures. Novices, by contrast, often use interpretive tools such as labels to support understanding. Consequently, label effectiveness may differ depending on the viewer's level of art-related expertise, underscoring the need to differentiate between audience types when evaluating label impact.

Beyond tracking eye movements, measuring pupil diameter offers an indication of cognitive and emotional processing. Increases in pupil diameter have been linked to heightened arousal, attentional effort, and deeper cognitive engagement (Laeng et al., 2012; Van Der Wel & Van Steenbergen, 2018). In addition to cognitive load, pupil dilation also plays a role in social and affective communication. For instance, Kret (2018) demonstrated that observers interpret dilated pupils as signals of interest or emotional engagement, underscoring their communicative function. These findings emphasize the dual function of pupil size in reflecting internal processing and influencing social interactions. To complement these physiological and behavioral measures, qualitative interviews can provide a deeper understanding of how visitors make sense of artworks and labels. Interviews capture subjective dimensions of museum engagement, such as how visitors interpret artworks, relate them to their prior knowledge or personal experience. As Leinhardt and Knutson (2004) emphasize, learning in museums often occurs through conversations and reflective meaning-making rather than passive observation alone.

This study bridges museum education, visual engagement and postcolonial critique. Conducted in collaboration with the Rijksmuseum, the national museum of the Netherlands which attracts over 2.7

million visitors annually (Rijksmuseum Verwelkomt Meer Publiek Dan Ooit—Rijksmuseum, 2025), the study investigates how different types of labels influence visitor engagement and perception. The museum, known for its extensive collection of Dutch Golden Age works, attracts a heterogeneous audience, including Dutch families, international tourists, and both casual and dedicated museumgoers. In line with contemporary audience research, this study categorizes visitors based on their motivations rather than their demographics. The framework draws primarily on Falk's work (2016), which proposes that visitors' experiences are shaped less by demographic characteristics and more by their visit-related identities, including interests, prior knowledge, and expectations for the museum visit. This perspective emphasizes that museums do not provide a single uniform experience but instead accommodate multiple identity-related modes of engagement. Complementing this identity-based perspective, the Rijksmuseum draws on the *Culture Segments* framework developed by the consultancy Morris Hargreaves McIntyre (Morris Hargreaves McIntyre, 2015). This framework was created by analyzing the "Audience Atlas", a large-scale survey of 4,557 adults engaged in arts, culture, and leisure activities. The Audience Atlas dataset provided the empirical foundation for identifying distinct motivational profiles, which were then formalized into the Culture Segments model.

Building on Falk's identity-based approach, the Rijksmuseum collaborated with the Dutch research agency Motivaction (Marcom, 2022) to refine its visitor segmentation framework and tailor it to its own audience. Motivaction recruited 1,420 respondents through its national panel and an external international panel to complete an online survey about their motivations for visiting museums, their prior engagement with art, and their expectations for cultural experiences. The international sample included 546 respondents from France, Germany, Italy, the United States, and the United Kingdom (approximately 100 per country). Analysis of these data led the Rijksmuseum to identify several motivation-based visitor identities that have since been used across internal research (Kintz, 2024). The largest segment, Pleasure Seekers (36%), comprises visitors who engage with art primarily for leisure and social enjoyment. Nightwatch Visitors (30%) are motivated predominantly by the desire to see Rembrandt's The Night Watch and represent a destination-driven profile, approximately 70% of this group are international visitors. This type of visitor, while labeled here after the Rijksmuseum's most iconic work, is not unique to this institution. Many major museums attract a substantial proportion of visitors who come primarily to see a single landmark painting or object that functions as a cultural attraction (e.g., the Mona Lisa at the Louvre or The Girl with a Pearl Earring at the Mauritshuis). Art Lovers (9%) approach artworks with sustained interest and domain-specific knowledge, seeking deeper contextual or historical meaning. The remaining visitors include diverse profiles such as families and casual visitors with varying motivations.

Two of the described identities are central to the present study: Art Lovers and Pleasure Seekers. These two profiles were selected for three reasons. First, they represent contrasting modes of museum engagement, one oriented toward deep art-historical and contextual interest, the other toward leisure and the immediate social experience, making them particularly suited for testing hypotheses about differential cognitive effort and reliance on interpretive materials. Second, together they account for nearly half (45%) of the Rijksmuseum's visitor population, ensuring practical relevance for the museum's label design strategy. Third, the remaining visitor profiles were not suitable for inclusion. Nightwatch Visitors were excluded because none of the selected stimulus paintings included The Night Watch, and because approximately 70% of this group are international visitors, whereas the present study required Dutch fluency due to the Dutch-language labels and interview protocol. The remaining visitor profiles were too heterogeneous to form a coherent analytical group.

Given the diverse backgrounds of its visitors, museums have been experimenting with different ways of presenting its collections. In 2013, the Rijksmuseum's educational department introduced Formal–Descriptive labels designed to guide visitors' attention to specific painting details, supporting a more structured viewing experience (Kintz, 2024). Recently, however, the museum has started to reconsider this approach, developing New Labels intended to promote historical awareness, particularly with regard to Dutch colonialism. These labels provide context for artworks within the socio-political landscape of the Dutch Golden Age, encouraging critical engagement with themes such as colonial expansion,

trade and power. Importantly, the two label types differ only through subtle shifts of emphasis. For example, both labels for the painting *The Castle of Batavia* describe the mixed market crowd, including Japanese, Indians,"Mardijkers" (formerly enslaved people), and a Dutch–Eurasian couple with an enslaved servant carrying a pajong. However, the Formal–Descriptive label highlights compositional details: "*A Javanese woman sells fruit, a Chinese man sells fish, and Moluccans play football with a rattan ball*", whereas the Contextual–Historical version stresses socio-political context: "*In reality, these population groups lived much more separately*." Thus, while the content largely overlaps, the shift in emphasis may guide visitors toward different modes of engagement. This study therefore examines whether these minimal variations in focus can meaningfully influence how visitors perceive and interpret artworks. To determine the effect of these small variations, the study compares both label types with a no-label condition, allowing us to isolate how the presence and framing of text influence viewers' perception and interpretation.

This study used a between-subjects 3 (Label Type: Formal–Descriptive, Contextual–Historical, No Label) × 2 (Visitor Type: Art Lovers vs. Pleasure Seekers) design. First, we hypothesize that Formal–Descriptive labels will direct visitors' gazes toward specific highlighted areas within the paintings. Second, we hypothesize that Contextual–Historical labels, with their historical focus, will encourage broader exploration of the artworks and stimulate more critical thinking as reflected in the interviews, particularly concerning colonial themes. We anticipate that Contextual–Historical labels will elicit a greater number of saccades and larger saccade amplitudes across the painting surface than Formal–Descriptive labels, as the historical framing is expected to prompt viewers to connect multiple elements of the scene rather than directing attention toward particular visual details. Third, we hypothesize that these historically focused labels may evoke stronger negative emotions, due to their emphasis on the complexities of Dutch colonial history. Fourth, we hypothesize that pleasure seekers will have larger pupil diameters than art lovers when reading any type of label, reflecting greater cognitive effort with the presented information. Fifth, we hypothesize that Pleasure Seekers will spend more time reading labels than Art Lovers, regardless of label type, due to their relatively lower levels of prior domain knowledge and greater need for interpretive support.

By analyzing gaze behavior, emotional responses, and visitor type, this study demonstrates how interpretive materials shape the museum experience. These findings contribute to a growing body of research on museum interpretation, offering practical insights for label design that balances clarity, engagement, and historical responsibility. This research underscores how museums, often viewed as neutral spaces, actively frame the narratives we tell about the past.

Methods

Sixty-nine visitors participated in the study over a period of three weeks. Participants were recruited on-site. Inclusion criteria required Dutch fluency and a minimum age of 16. All participants had normal or corrected-to-normal vision and provided informed consent. The study was approved by the Ethics Committee of Leiden University and conducted in accordance with the Declaration of Helsinki.

Materials

Three 17th-century paintings were selected: *Het Kasteel van Batavia* by Andries Beeckman, 1662 (108 × 151,4 cm), *Pronkstilleven* by Adriaen van Utrecht, 1644 (186 × 243 cm), and *De terugkomst in Amsterdam van de tweede expeditie naar Oost-Indie* by Hendrik Cornelisz Vroom, 1599 (102,3 × 218,4 cm). For clarity, these paintings will be referred to as KVB, Pronkstilleven, and Ships. Paintings were selected based on three key criteria. First, works were chosen for their visual complexity, excluding e.g. portraits to avoid the gaze-drawing effect of faces (Theeuwes & Van der Stigchel, 2006; Villani et al., 2015). Second, the selected paintings were located in close proximity within the museum, minimizing walking time between stimuli and reducing participant fatigue. Third, paintings were chosen from areas with comparable low visitor density to limit external distractions and ensure uninterrupted viewing.

The study included three label conditions: (1) Formal–Descriptive labels, directing attention to specific painting areas; (2) Contextual–Historical

labels, emphasizing historical and colonial context; and (3) a control condition with no label (Appendix A). All labels were printed on A4 paper and placed over original labels. In the no-label condition, a blank A4 paper was used to control visual presence.

Visitor type was assessed using the Rijksmuseum's validated five-item segmentation questionnaire (Appendix B), rated on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). A composite score was calculated by averaging all five items. Participants were then classified into visitor types based on their composite score using the classification criteria established in the Rijksmuseum's visitor segmentation framework. Participants with higher composite scores, reflecting stronger agreement with statements about valuing museum visits and interest in art, were classified as Art Lovers (n = 39), while those with lower scores, indicating a preference for leisure-oriented experiences, were classified as Pleasure Seekers (n = 28). Two participants could not be unambiguously classified. One of these was subsequently excluded due to technical issues.

To provide additional context for the visitor type classification, we examined participants' education levels and prior museum visit history. Education levels were broadly comparable across Art Lovers and Pleasure Seekers: 85.3% of Art Lovers and 85.7% of Pleasure Seekers held a Bachelor's degree or higher, while 14.7% of Art Lovers and 14.3% of Pleasure Seekers had completed high school or an apprenticeship. Art Lovers had a somewhat higher proportion of doctoral degrees (14.7%) compared to Pleasure Seekers (3.6%). However, the two groups differed notably in the recency of their visits to the Rijksmuseum: 52.9% of Art Lovers had visited within the past 12 months, compared to only 10.7% of Pleasure Seekers, while 71.4% of Pleasure Seekers last visited two or more years ago or had not visited before. This pattern supports the distinction between the two profiles, suggesting that Art Lovers maintain a more sustained engagement with the museum beyond self-reported attitudes.

Data from six participants were excluded due to technical or environmental issues (e.g., disruptive tour guides or low gaze data), resulting in a final sample of 34 Art Lovers, 28 Pleasure Seekers, and 1 unclassified participant (N = 63). In the final sample, Art Lovers were distributed across the Formal–Descriptive (n = 13), Contextual–Historical (n = 9), and No Label (n = 12) conditions, while Pleasure Seekers were distributed across the Formal–Descriptive (n = 9), Contextual–Historical (n = 11), and No Label (n = 8) conditions. The final sample size aligns with or exceeds comparable eye tracking museum studies (e.g. Castellotti et al., 2023; Davies et al., 2017; Walker et al., 2017, 2024).

Procedure

To ensure real-world relevance, the study took place in the Rijksmuseum, focusing on paintings that were on display at the time. Previous studies have shown that artworks may be perceived differently in natural environments, such as museums, than in laboratories (Brieber et al., 2015; Estrada-Gonzalez et al., 2020).

Participants first completed a baseline Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Before beginning the task, they signed an informed consent form and were instructed to view each painting naturally and to read the label if one was present. They then viewed the three paintings in counterbalanced order. A one-point calibration of the eye tracker was performed, and a floor marker standardized initial viewing distance ($\sim$ 1.5 m; visual angle: 20–25°). Participants were then free to move. Each artwork was seen for a fixed viewing time of 75 s, which is longer than the museum average of approx. 27.2 s (Smith & Smith, 2001). This enabled visitors to read the labels thoroughly and explore the artworks in more detail. Participants were instructed to view naturally and consider any present label. Immediately after each viewing, participants completed a 7-item aesthetic response questionnaire developed by Castelotti (2023; see Appendix C). After viewing all three paintings, participants retook the PANAS and completed a brief interview (adapted from Walker et al., 2024). Total participation time was $\sim$ 30 min.

Eye tracking

Eye movements were recorded with Tobii Pro Glasses 3 (100 Hz; 0.6° accuracy). Participants with less than 50% valid gaze data were excluded entirely. Those with 50–80% valid gaze data were identified, and their recordings were manually reviewed to assess data quality, particularly during periods of viewing the artwork. Participants whose gaze data from these

segments were considered insufficient for reliable analysis were excluded from further analysis. Eye Tracking data were processed using Tobii Pro Lab software Version 1.195 (Tobii, 2024). Manual intervals isolated painting-viewing periods and the I-VT gaze filter was applied (Olsen & Matos, 2012). Gaze data were automatically mapped with a 50% similarity threshold. Mapping quality was manually checked and adjusted if needed.

Saliency maps were generated using a Vision Transformer (ViT: Dosovitskiy et al., 2020) with Gradient-weighted Class Activation Mapping (Grad-CAM) to benchmark visually salient features (Selvaraju et al., 2016). Paintings were resized and normalized to fit the model input. Grad-CAM visualizations highlighted regions driving model predictions, as an example, the saliency map for *Pronkstilleven* is shown in Fig. 1.

Areas of Interest (AOIs) were defined in Tobii Pro Lab: salient regions (according to the saliency maps) and label-highlighted areas (areas mentioned in the label). Additional AOIs covered each entire painting and label.

For Pronkstilleven (Fig. 2), eleven salient AOIs were defined: parrot, cut pâté, central fruits, grapes, tableware, lobster, fruit on white cloth, monkey eating, half-shorn dog, tilted bottle, and fallen fruit. In both label conditions, seven label-based AOIs (e.g., cut pâté, grapes, bottles) overlapped with salient features.

For KVB (Fig. 3), seven salient AOIs were defined, including: palm trees, flowered balcony, Dutch-Eurasian couple with enslaved servant, Javanese women selling fruit, Chinese fisher, Moluccans playing football, and the castle. Four label-based AOIs (e.g., Dutch-Eurasian couple, Javanese women) overlapped.

For Ships (Fig. 4), three salient AOIs were defined: large central ships, three foreground boats with sails (three AOIs), and a small boat with red flag. One Formal–Descriptive -label AOI (central ships) overlapped. In the Contextual–Historical Label Condition, five AOIs overlapped, including ships and cannon-hit vessels.

Eye Tracking metrics included: average duration of fixation, time to first fixation, average fixation duration, pupil diameter, average duration of visit, duration of first visit, number of saccades in AOI (normalized by total duration of visit) and average saccade amplitude. Data preprocessing was conducted in RStudio (version 2025.05.1 + 513; Posit team, 2025). This included the removal of empty AOIs and the recoding of categorical variables, such as condition, visitor type, and media type, into nominal numeric values for analysis.

A linear mixed-effects model (LMM) was used to analyze the eye tracking data. Fixed effects included label condition (Formal–Descriptive, Contextual–Historical vs. No Label) and visitor type (Art Lovers vs. Pleasure Seekers). Both effects were treated as between-subject factor. To account for repeated measures and variability across stimuli, random intercepts were included for both participants and paintings. The normality of residuals was checked using Q–Q plots, the Shapiro–Wilk test, and skewness values. When necessary, data were transformed using square root or logarithmic transformations. Analysis was conducted in JASP (version 0.19.3; JASP Team, 2025).

Average saccade amplitude was measured using whole saccades, partial saccades were excluded. To be included in the analysis, saccades had to both start and end within the painting Area of Interest (AOI) and fall within the defined Time of Interest (TOI), which was the full fixed viewing period for each artwork (from the start of viewing until the end of the 75-s viewing time). The analysis was conducted using a repeated measures ANOVA in JASP.

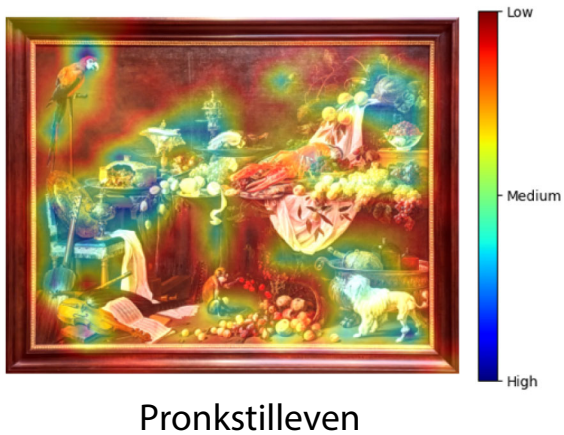

Fig. 1 Saliency Maps: Saliency map for Pronkstilleven

a) Formal–Descriptive Label Condition

b) Contextual–Historical Label Condition

c) No Label Condition

Fig. 2 Areas of Interest (AOIs) for Pronkstilleven across the three label conditions. Each colored outline represents a distinct AOI. Colors were automatically assigned to visually distinguish individual areas and carry no additional meaning

a) Formal–Descriptive Label Condition

b) Contextual–Historical Label Condition

c) No Label Condition

Fig. 3 Areas of Interest (AOIs) for KVB across the three label conditions. Each colored outline represents a distinct AOI. Colors were automatically assigned to visually distinguish individual areas and carry no additional meaning

a) Formal–Descriptive Label Condition

b) Contextual–Historical Label Condition

c) No Label Condition

Fig. 4 Areas of Interest (AOIs) for Ships across the three label conditions. Each colored outline represents a distinct AOI. Colors were automatically assigned to visually distinguish individual areas and carry no additional meaning

Interview and language analysis

Interviews were recorded, transcribed, translated and corrected manually. The CATMA platform (Gius et al., 2025) was used to annotate recurring categories, including references to location, history or slavery.

Python-based text analysis removed stop words from interviews and labels (see Appendix D). Word frequencies per participant were calculated. These were compared with the length of the Formal–Descriptive Label (total of 102 non-filler words for all three painting-labels combined) and the Contextual–Historical Label (total of 125 non-filler words for all three painting-labels combined). Vocabulary proportions were calculated for each participant:

- Proportion of Formal–Descriptive label words = (102) / Total words * 10,000
- Proportion of Contextual–Historical Label words = (125) / Total words * 10,000

One-way ANOVAs compared label-related vocabulary across conditions. If necessary, square-root transformation was used for normality.

Questionnaires

The PANAS was conducted pre- and post-viewing. Affect changes were analyzed using paired t-tests and Wilcoxon tests (based on normality). Kruskal–Wallis tests explored group differences by label condition. Nonparametric tests addressed skewed distributions and ties. The short aesthetic questionnaire between paintings was checked for the assumptions of normality and equal group variance using normality plots and Levene's test respectively. A one-way ANOVA was performed comparing the seven items to the three label conditions (Formal–Descriptive, Contextual–Historical, No Label) and the visitor types (Art Lovers, Pleasure Seekers).

Results

Eye tracking data

Each painting was viewed for a fixed duration of approximately 75 s, timed by the experimenter, who informed participants when to stop looking. As such, total viewing time was consistent across participants and conditions but varied slightly due to the manual timing procedure. Across all recorded viewing intervals in the final sample, the mean interval duration was 76.1 s (SD = 10.5). Participants in the Contextual–Historical Label condition spent significantly more time on their initial visit to label-specific AOIs (i.e., predefined areas covering areas from the label text) compared to those in the Formal–Descriptive Label condition, $F(1, 85.90) = 4.23$, $p = .043$. This finding suggests that the Contextual–Historical Labels prompted greater immediate engagement or required more cognitive processing upon first encounter. Mean durations (log-transformed) were 2.86 (SD = 0.52) for the Contextual–Historical Label Condition and 2.73 (SD = 0.42) for the Formal–Descriptive Label Condition.

Contrary to our hypothesis, participants in the Formal–Descriptive Label condition exhibited a significantly higher normalized saccade count within label-specific AOIs than those in the Contextual–Historical Label Condition, $F(1, 45.22) = 5.17$, $p = .028$. This may suggest that Formal–Descriptive labels prompt more exploratory or less focused visual behaviors, as opposed to the more structured or guided attention patterns prompted by Contextual–Historical Labels. This effect was specific to label AOIs and did not extend to whole-painting or salient AOIs.

Pleasure Seekers had significantly longer average viewing durations of the labels compared to Art Lovers, $F(1, 39.73) = 6.49$, $p = .015$, suggesting deeper engagement or a greater need for processing. The mean visit duration was 97.70 s (SD = 32.21) for Pleasure Seekers and 76.63 s (SD = 35.01) for Art Lovers.

Pleasure Seekers also had significantly larger average pupil sizes (M = 5.10, SD = 0.87) than Art Lovers (M = 4.30, SD = 0.73), $F(1, 37.92) = 7.30$, $p = .01$, suggesting higher cognitive load or arousal (Van Der Wel & Van Steenbergen, 2018) during label processing. A similar pattern emerged when analyzing pupil diameter restricted to AOIs covering the label content. Pleasure Seekers again had significantly larger average pupil sizes (M = 5.08, SD = 0.83) than Art Lovers (M = 4.39, SD = 0.73), $F(1, 38.94) = 6.47$, $p = .015$. In contrast, no significant differences in pupil diameter were found for AOIs related to the overall painting or salient areas, suggesting that the observed effect was specific to the label content.

Although we expected the type of label to influence how broadly participants scanned the paintings, as reflected in differences in saccade amplitude, no such effects were observed. Similarly, no differences in gaze allocation to salient regions of the artworks were observed across conditions, suggesting that bottom-up attentional guidance remained stable regardless of label content.

Interviews

Art Lovers used significantly more history-related words ($M = 3.0$, $SD = 1.3$) than Pleasure Seekers ($M = 2.3$, $SD = 1.2$), $t(60) = 2.18$, $p = .033$, $d = 0.56$. This difference was not due to overall word count differences between the groups. The proportion of words referencing the Formal–Descriptive or Contextual–Historical Labels did not differ significantly across conditions, $F(2, 60) = 0.15$, $p = .864$ (Formal–Descriptive), and $F(2, 60) = 0.16$, $p = .856$ (Contextual–Historical). This indicated that participants referred to label content at similar rates, regardless of their condition.

Interview data revealed further variations in engagement when discussing the paintings. Some participants shared personal reactions, while others appeared more detached. Although all participants were Dutch, only 41.7% explicitly identified with the historical content, using terms like "we" or "our country". The majority (58.3%) used distancing language, such as "them", "the VOC", or "the Dutch".

In the Formal–Descriptive Label condition, 59.1% of participants specifically mentioned the labels during the interview. Among them, 22.7% expressed negative reactions: participants described the labels as "not enlightening" (participant 61) or found them confusing and inadequate for understanding the historical context of the paintings (participants 4, 62, 63). Several participants also expressed a need for more information, particularly regarding the Ships painting, where visitors felt the label did not sufficiently explain what was depicted (participants 2, 4, 48, 53, 61, 62). In the Contextual–Historical Label condition, 50% of participants commented on the labels, with only 10% expressing negative opinions, one participant noted they could not see something described in the text in the painting (participant 58), while another expressed some confusion (participant 62). The remaining responses were neutral or positive.

Regardless of condition, the KVB label was referenced most frequently. Notably, 14.3% of participants found the painting confusing, irrespective of condition, and appreciated contextual information that aided interpretation. In the Contextual–Historical Label condition, the final sentence of the KVB label, which stated that the depicted social groups were more segregated in reality, left a strong impression: 25% of participants in this condition referenced that sentence, highlighting its impact on interpretation. Overt expressions of strong negative emotions such as guilt, shame, or anger in response to the colonial content were rare across all conditions, consistent with the PANAS findings showing no significant changes in negative affect.

PANAS

Participants reported a significant increase in positive emotions after viewing the paintings ($M = 34.0$, $SD = 6.1$) compared to before ($M = 32.5$, $SD = 5.6$), $t(62) = 2.98$, $p = .004$, 95% CI [0.5, 2.5], $d = 0.38$.

When analyzed by condition (Table 1), only the Contextual–Historical Label and No Label Conditions showed significant increases. In the Contextual–Historical Label Condition, the mean increase was 1.4 (95% CI [-0.2, 3.0]), $t(19) = 1.79$, $p = .045$, $d = 0.40$. The No Label Condition showed a mean increase of 3.0 (95% CI [0.9, 5.2]), $t(20) = 2.91$, $p = .004$, $d = 0.64$. The Formal–Descriptive Label Condition showed no significant change ($p = .401$).

Negative emotions showed no significant changes before and after viewing ($z = -1.74$, $p = .081$) or across label conditions ($\chi^2(2) = 2.29$, $p = .319$).

Short aesthetic questionnaire

The item "The information about the artworks was easy to understand" differed significantly for the Pronkstilleven painting: $F(2, 38.78) = 5.10$, $p = .011$. Post hoc tests showed higher ratings for Formal–Descriptive ($M = 4.10$, $SD = 0.77$) and Contextual–Historical Label ($M = 4.26$, $SD = 0.96$) compared to No Label ($M = 3.00$, $SD = 1.58$). A similar trend appeared for the KVB painting, but the effect only approached significance $F(2, 35.77) = 3.132$, $p = .056$. These item-level analyses were conducted

Table 1 Means and standard deviations of positive emotion scores by condition

	N	Before Positive		After Positive		Positive emotion change	
		M	SD	M	SD	M	SD
Formal–Descriptive Label Condition	22	32.1	6.4	32.3	7.0	0.2	3.4
Contextual–Historical Label Condition	20	33.0	5.5	34.4	5.7	1.4*	3.5
No Label Condition	21	32.4	5.2	35.4	5.4	3.0*	4.8
Overall	63	32.5	5.6	34.0	6.1	1.5	4.1

*Significant differences are marked with

for each painting because the questionnaire was completed immediately after viewing the artwork in order to capture brief, specific reactions (7 items; see Appendix C for the full questionnaire).

For the item "I experienced negative emotions while viewing the artworks" in the KVB, label condition affected ratings $F(2, 38) = 3.16$, $p = .049$. Participants in the Formal–Descriptive Label Condition reported more negative emotions ($M = 2.43$, $SD = 1.08$) than those in the No Label Condition ($M = 1.65$, $SD = 0.93$), $\eta^2 = 0.092$. Other items showed no significant differences.

Discussion

This study examined how different types of labels influence visitors' engagement with colonial themed artworks and how these effects vary depending on visitors' prior interests in art. Using eye tracking, self-report measures, and interviews, we investigated how Formal–Descriptive and Contextual–Historical labels shape viewing behavior, emotional responses, and interpretation. Rather than examining whether visitors engaged more with labels themselves, the focus was on how labels structured engagement with the artworks. Findings partially supported our hypotheses. Pleasure Seekers demonstrated greater cognitive effort and engagement with labels, while Contextual–Historical labels shaped attention and interpretive depth but did not increase negative emotions. These results highlight how visitor characteristics and label design interact to influence museum experiences across cognitive, affective, and interpretive dimensions.

Pleasure Seekers exhibited larger pupil diameters and spent more time reading labels than Art Lovers. This pattern suggests greater cognitive effort during text processing and aligns with our expectation that Pleasure Seekers would show higher cognitive load (Hypothesis 4) and longer label engagement (Hypothesis 5). Pupil diameter is a multifaceted measure that is sensitive to cognitive processing but also influenced by visual characteristics of the stimuli and eye movement dynamics (Beatty & Lucero-Wagoner, 2000). However, pupil diameter in naturalistic viewing contexts should be interpreted with caution, as it can be influenced not only by cognitive demands but also by visual properties of the stimuli and eye movement dynamics, including saccades. Given that participants viewed colorful artworks and moved freely between text and image, the observed pupil differences cannot be attributed unambiguously to cognitive load. Nevertheless, the combination of longer label engagement and larger pupil diameters suggests that Pleasure Seekers may have required more effort to integrate textual information with the artwork or engaged with the labels in a more deliberate manner. This aligns with previous research suggesting that visitors with less specific knowledge of the subject rely more on interpretive materials (Pihko et al., 2011; Vogt & Magnussen, 2007).

Participants in the Contextual–Historical Label condition spent more time on their initial visit to label-specific AOIs and made fewer saccades, indicating more focused reading. These findings support our expectation that Contextual–Historical labels would prompt greater initial engagement with label-related content (partially supporting Hypothesis 1). However, the saccade data did not support Hypothesis 2. Rather than encouraging broader exploration, participants in the Formal–Descriptive Label condition made significantly more saccades within label-specific AOIs, suggesting more fragmented visual scanning in that condition. The results suggests that

the Contextual–Historical Labels either prompted more immediate interest or required more cognitive effort to comprehend. Saccade data provide further insight into how attention is allocated. Participants in the Formal–Descriptive Label Condition made significantly more saccades within label-specific AOIs, suggesting that their visual scanning was more fragmented or exploratory (Rayner, 2009). In contrast, the Contextual–Historical labels may have guided attention more effectively, enabling participants to focus on key points with fewer gaze shifts.

Interview analysis further highlighted these patterns. Art lovers were more likely to use historically specific terminology in their interpretations, suggesting a stronger integration of prior knowledge. This finding aligns with research indicating that prior experience and domain-specific knowledge influence how individuals interact with and learn from museum texts (Falk & Dierking, 2016). Participants in the Contextual–Historical Label condition were more likely to praise specific elements of the text, particularly those addressing social or political issues. For example, one quarter of participants in the Contextual–Historical Label condition quoted a sentence from the KVB label about historical segregation, emphasizing its ability to encourage reflective engagement. This finding is consistent with previous research emphasizing the importance of interpretive framing in facilitating critical reflection and meaning-making in museums (Leinhardt & Knutson, 2004). The majority of participants used distancing language when discussing colonial themes, reflecting a psychological separation from identity-threatening historical narratives. This tendency was consistent across conditions and aligns with prior research on how people manage cognitive dissonance when confronted with morally troubling aspects of their group's history (Land-Zandstra et al., 2020; Smith, 2011). The results highlight a challenge for museums: even when presenting historically complex content, visitors may resist personal identification with morally troubling histories.

It should also be noted that the two label types were not equally distinct across all three paintings. While the labels for Pronkstilleven and Ships differed substantively in their emphasis, with the Formal–Descriptive labels focusing on compositional details and the Contextual–Historical labels foregrounding colonial context, the KVB labels shared most of their descriptive content, including references to the same population groups and activities. The primary difference lay in the Contextual–Historical label's concluding sentence, which stated that the depicted social groups lived much more separately in reality. This overlap means that the KVB labels represent a more subtle manipulation compared to the other two paintings, and condition-specific effects for this painting should be interpreted accordingly. Indeed, interview data showed that participants in both label conditions engaged most extensively with the KVB label, suggesting that its content resonated with visitors regardless of the framing condition. Nevertheless, the finding that 25% of participants in the Contextual–Historical condition spontaneously referenced the final sentence about historical segregation demonstrates that even minimal shifts in framing can meaningfully influence interpretation. Future research should aim to develop label manipulations that are more consistently distinct across all stimuli, to allow clearer attribution of effects to label content rather than to characteristics of specific paintings.

Negative affect remained stable across all conditions, indicating that presenting historically complex content did not lead to heightened emotional discomfort. This finding is particularly important for museums, as it suggests that institutions can address sensitive historical themes without alienating visitors, supporting efforts toward inclusive and responsible interpretation. These results run counter to our expectation that Contextual–Historical labels would evoke stronger negative emotions (Hypothesis 3). Positive emotions increased overall, with significant increases in the Contextual–Historical and No Label conditions, the latter showing the largest increase. This pattern suggests that the Contextual–Historical labels may have encouraged a more analytical or reflective mode of engagement, drawing attention to historically sensitive themes rather than producing a stronger positive emotional response. By contrast, the absence of a label may have allowed viewers to focus more freely on the aesthetic qualities of the paintings, which was associated with a larger increase in positive affect.

Responses to the aesthetic questionnaire revealed nuanced effects on both clarity and negative emotions. For *Pronkstilleven*, participants in both label conditions rated the information as easier to understand than those in the No Label condition. A similar, though non-significant, trend was observed for the *KVB*

painting. In addition to clarity, participants in the Formal–Descriptive Label condition reported higher negative emotions when viewing the *KVB* painting compared to participants in the No Label condition. This finding is noteworthy given the overall increase in positive affect described earlier. It suggests that, while the Contextual–Historical and No Label conditions supported positive engagement, the use of Formal–Descriptive labels may introduce tension by failing to address the sensitive historical themes clearly depicted in the painting. Overall, these item-level findings suggest that clarity and framing can shape comprehension and emotional tone, but generalization beyond these paintings should be cautious, as results are only significant for specific paintings. The nuances align with Falk and Dierking's (2016) claim that the creation of meaning in museums is influenced by personal, sociocultural and physical contexts, including the clarity and relevance of interpretive materials.

While this study provides valuable insights, several limitations should be noted. Firstly, although the controlled viewing times are essential for comparison, they do not fully replicate the way visitors naturally behave in museums, where they determine their own engagement duration. This limitation may have concealed individual differences in interaction with the exhibits. Furthermore, some visitors had just entered the museum whereas others were about to leave, which may have had an influence especially on the PANAS questionnaire. Thirdly, although the sample size exceeded that of similar studies (e.g. Castellotti et al., 2023; Davies et al., 2017; Walker et al., 2017), it was insufficient to detect subtle interaction effects, particularly between subgroups like Art Lovers and Pleasure Seekers. Finally, reliance on self-reports to classify visitors may have introduced bias. Although we examined education levels and museum visit recency to contextualize the visitor type classification, participants' domain-specific art-historical knowledge was not directly assessed. The visitor type classification captures general engagement orientation and is supported by behavioral indicators such as visit frequency, but it does not measure familiarity with specific art-historical periods, movements, or the colonial themes central to this study. Future studies should incorporate objective knowledge measures, such as recognition tasks or art-historical terminology quizzes, alongside behavioral measures of engagement, such as time spent in galleries, to more precisely isolate the role of prior knowledge in shaping museum experiences. In addition, future research should explore naturalistic viewing conditions, increase sample diversity and use objective measures of knowledge. In particular, studies should examine how identity and labels interact to influence experiences of museums, especially with regard to sensitive topics. Labels that encourage personal identification with history and address disengagement tendencies may encourage reflection and emotional connection. Further research should also investigate how label length and specificity impact understanding across different demographic groups, providing valuable insights for the design of labels that are both inclusive and effective.

This study contributes to a growing understanding of how interpretive design and visitor characteristics interact to shape museum engagement. From a theoretical perspective, the findings extend models of top-down attentional guidance (Henderson & Hayes, 2017; Itti & Koch, 2000) to the museum context, demonstrating that even subtle differences in label framing can modulate visual attention and interpretive depth. The differentiated responses of Art Lovers and Pleasure Seekers further underscore the importance of accounting for visitor motivation and prior engagement when modelling aesthetic experience (Falk, 2016; Leder et al., 2004). The finding that Pleasure Seekers exhibited larger pupil diameters and longer label engagement aligns with research on expertise differences in visual processing (Pihko et al., 2011; Vogt & Magnussen, 2007) and suggests that interpretive materials place differential cognitive demands on visitors depending on their background. Practically, these findings offer direct guidance for museum professionals. First, historically sensitive labels can be integrated into exhibitions without provoking visitor discomfort, a concern that has historically inhibited museums from addressing colonial themes (Dann & Seaton, 2001; Smith, 2011). Second, label design should be informed by an understanding of audience diversity. Museums may benefit from offering layered interpretive materials, for example, combining concise descriptive text with optional historical context, to accommodate both Art Lovers seeking depth and Pleasure Seekers who may need more scaffolding. Third, the finding that even a single reframing sentence (as in the KVB Contextual–

Historical label) can leave a lasting impression on visitors highlights the interpretive power of carefully chosen language. More broadly, this research reinforces the view that museums are not neutral spaces but active agents in shaping historical narratives, and that the design of even brief interpretive texts carries significant weight in how visitors understand and relate to the past.

Acknowledgements We thank Tobii AB for providing the eye tracking hardware and software used in this study.

Author contribution Z.P. conceptualised the study, coordinated the collaboration with the museum partner, led the collection of data, conducted the primary analysis, wrote the initial manuscript M.E.K. contributed to the design of the study, provided theoretical input T.H., G.S., and S.W. contributed to data collection and preprocessing of data, provided input on the analyses A.B. and P.K. contributed to the development of the interpretive materials and supported data collection at the museum site L.v.d.B. contributed to technical and methodological support F.W. contributed to the study design, provided methodological and theoretical guidance All authors reviewed, edited, and approved the final manuscript.

Funding Mariska Kret ERC Starting grant # 804582.

Data availability Approval was obtained from the ethics committee of Leiden University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Declarations

Conflict of interest The authors declare no competing interests.

Appendix A: Label for each Painting

Painting	Label Formal–Descriptive Label Condition: Written in 2013 to guide the visitor's view	Label Contextual–Historical Label Condition: Written in 2023 to focus on historical awareness
Pronkstilleven by Adriaen van Utrecht (1644)	De Vlaming Adriaen van Utrecht liet hier zien dat hij werkelijk alles kon schilderen: kostbaar vaatwerk, glas, vruchten, een enorme kreeft op een Chinese schaal, een aangesneden pastei en nog veel meer. Gezien het opvallend lage standpunt zal het grote schilderij wel bedoeld zijn geweest om boven een schoorsteen te hangen	De Vlaming Adriaen van Utrecht liet hier zien dat hij werkelijk alles kon schilderen: kostbaar vaatwerk, glas, vruchten, een enorme kreeft op een Chinese schaal, een aangesneden pastei. In de pastei zitten specerijen zoals kruidnagel en nootmuskaat. Die werden door de Verenigde Oost-Indische Compagnie (VOC) vanuit Azië naar Nederland gehaald, vaak met geweld. Muskaatnoten werden geplukt op de plantages door tot slaaf gemaakte mensen
English Translation: Still Life by Adriaen van Utrecht (1644)	The Flemish artist Adriaen van Utrecht demonstrated here that he could paint absolutely anything: precious tableware, glassware, fruit, an enormous lobster on a Chinese platter, a slice of pie and much more. Given the strikingly low viewpoint, this large painting was probably intended to hang above a fireplace	The Flemish artist Adriaen van Utrecht demonstrated here that he could paint absolutely anything: precious tableware, glassware, fruit, an enormous lobster on a Chinese platter, a slice of pie. The pie contains spices such as cloves and nutmeg. These were brought to the Netherlands from Asia by the Dutch East India Company (VOC), often by force. Nutmegs were picked on plantations by enslaved people

Painting	Label Formal–Descriptive Label Condition: Written in 2013 to guide the visitor's view	Label Contextual–Historical Label Condition: Written in 2023 to focus on historical awareness
Het Kasteel van Batavia by Andries Beeckman (1662)	De markt van Batavia, op de achtergrond de vesting van de VOC. Een Javaanse verkoopt fruit, een Chinees vis en Molukkers voetballen met een rotan bal. Het marktpubliek bestaat uit Japanners, Indiërs, 'mardijkers' – voormalige tot slaaf gemaakte mensen, herkenbaar aan hun gestreepte kledij – en een Hollands-Indisch echtpaar, gevolgd door een man in slavernij met pajong (zonnescherm). Het schilderij pronkte in de vergaderzaal van het Oost-Indisch Huis in Amsterdam	De bezoekers van de markt in Batavia beeldt Beeckman specifiek af. Dit schilderij hing in de vergaderzaal van de VOC in Amsterdam. Te zien zijn Japanners, Indiërs, 'mardijkers' – voormalig tot slaaf gemaakte mensen, herkenbaar aan hun gestreepte kledij – en een Hollands-Euraziatisch echtpaar en hun tot slaaf gemaakte bediende met een pajong (zonnescherm). Een Javaanse vrouw verkoopt fruit, een Chinese man vis en Molukkers voetballen met een rotan bal. In werkelijkheid leefden deze bevolkingsgroepen veel meer gescheiden
English Translation: The Castle of Batavia by Andries Beeckman (1662)	The market of Batavia, with the VOC fortress in the background. A Javanese woman sells fruit, a Chinese man sells fish, and Moluccans play football with a rattan ball. The market crowd consists of Japanese, Indians, "mardijkers" – former slaves, recognisable by their striped clothing – and a Dutch-Indonesian couple, followed by a man in slavery with a pajong (sunshade). The painting was displayed in the meeting room of the East India House in Amsterdam	Beeckman depicts the visitors to the market in Batavia in detail. This painting hung in the meeting room of the Dutch East India Company in Amsterdam. It shows Japanese, Indians, 'mardijkers' – former slaves, recognisable by their striped clothing – and a Dutch-Eurasian couple and their enslaved servant with a pajong (sunshade). A Javanese woman sells fruit, a Chinese man sells fish, and Moluccans play football with a rattan ball. In reality, these population groups lived much more separately
De terugkomst in Amsterdam van de tweede expeditie naar Oost-Indië by Hendrik Cornelisz Vroom (1599)	Onder leiding van Jacob Cornelisz van Neck vertrokken in 1598 acht Nederlandse schepen naar Indië. Een jaar later, op 19 juli 1599, keerden de eerste vier uit Bantam (Java) terug. De andere schepen waren doorgevaren naar de Molukken. Ook die kwamen veilig terug, met nootmuskaat, foelie en kruidnagel aan boord	In 1598 vertrokken acht Nederlandse schepen naar de Indonesische archipel, op zoek naar rijkdommen. Al na een jaar waren de eerste vier terug in Amsterdam. Volgeladen met nootmuskaat, foelie en kruidnagel. Scheepjes varen ze tegemoet, er wordt gejuicht, kanonschoten klinken. Hier begon niet alleen de grootschalige handel in specerijen, maar ook de Nederlandse koloniale macht waarbij dwang en fors geweld niet werden geschuwd
English Translation: The return to Amsterdam of the second expedition to the East Indies by Hendrik Cornelisz Vroom (1599)	Under the command of Jacob Cornelisz van Neck, eight Dutch ships set sail for the Indies in 1598. A year later, on 19 July 1599, the first four returned from Bantam (Java). The other ships had sailed on to the Moluccas. They too returned safely, with nutmeg, mace and cloves on board	In 1598, eight Dutch ships set sail for the Indonesian archipelago in search of riches. After just one year, the first four were back in Amsterdam, laden with nutmeg, mace and cloves. Small boats sailed out to meet them, cheers rang out and cannon shots were fired. This marked not only the beginning of large-scale trade in spices, but also the start of Dutch colonial power, which did not shy away from coercion and brute force

Dutch Version.

In welke mate ben je het eens met de volgende stellingen?				
Zeer oneens	Oneens	Noch mee eens, noch mee oneens	Mee eens	Zeer mee eens
Ik zie een museumbezoek als een verrijking				
Ik bezoek graag musea				
Van een nieuwe tentoonstelling krijg ik meteen jeuk om het museum te bezoeken				
Ik ben helemaal niet geïnteresseerd in kunst				
Ik breng liever een dag door in een attractie dan in het museum				

English Translation.

To what extent do you agree with the following statements?				
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I see a visit to a museum as an enrichment				
I enjoy visiting museums				
A new exhibition immediately makes me want to visit the museum				
I am not at all interested in art				
I would rather spend a day at an amusement park than at a museum				

Appendix C: Aesthetic Emotions Questionnaire

Dutch Version.

	Zeer oneens	Oneens	Noch mee eens, noch mee oneens	Mee eens	Zeer mee eens
Ik waardeer de tentoongestelde kunstwerken					
Het kunstwerk trok mijn interesse					
Ik vond de kunstwerken complex en tot nadenken stemmend					
De informatie over de kunstwerken was makkelijk te begrijpen					
Ik ervoer positieve emoties tijdens het bekijken van de kunstwerken					
Ik ervoer negatieve emoties tijdens het bekijken van de kunstwerken					
De kunstwerken maakten me nieuwsgierig naar andere kunstwerken in het museum					

English Translation.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I appreciate the artworks on display					
The artwork caught my interest					
I found the artworks complex and thought-provoking					
The information about the artworks was easy to understand					
I experienced positive emotions while viewing the artworks					
I experienced negative emotions while viewing the artworks					
The artworks made me curious about other artworks in the museum					

Appendix D: Removed Stop Words

A, about, above, after, again, against, ain, all, am, an, and, any, are, aren, aren't, as, at, be, because, been, before, being, below, between, both, but, by, can, couldn, couldn't, d, did, didn, didn't, do, does, doesn, doesn't, doing, don, don't, down, during, each, few, for, from, further, had, hadn, hadn't, has, hasn, hasn't, have, haven, haven't, having, he, her, here, hers, herself, him, himself, his, how, I, if, in, into, is, isn, isn't, it, it's, its, itself, just, ll, m, ma, me, mightn, mightn't, more, most, mustn, mustn't, my, myself, needn, needn't, no, nor, not, now, o, of, off, on, once, only, or, other, our, ours, ourselves, out, over, own, re, s, same, shan, shan't, she, she's, should, should've, shouldn, shouldn't, so, some, such, t, than, that, that'll, the, their, theirs, them, themselves, then, there, these, they, this, those, through, to, too, under, until, up, ve, very, was, wasn, wasn't, we, were, weren, weren't, what, when, where, which, while, who, whom, why, will, with, won, won't, wouldn, wouldn't, y, you, you'd, you'll, you're, you've, your, yours, yourself, yourselves.

References

Beatty, J., & Lucero-Wagoner, B. (2000). The pupillary system. In Cacioppo JT, Tassinary LG, & Berntson GG (eds.) *Handbook of psychophysiology* (2nd ed., pp. 142–162)

Brieber, D., Nadal, M., & Leder, H. (2015). In the white cube: Museum context enhances the valuation and memory of art. *Acta Psychologica, 154*, 36–42. https://doi.org/10.1016/j.actpsy.2014.11.004

Castellotti, S., D'Agostino, O., Mencarini, A., Fabozzi, M., Varano, R., Mastandrea, S., Baldriga, I., & Viva, M. M. D. (2023). Psychophysiological and behavioral responses to descriptive labels in modern art museums. *PLoS ONE, 18*(5), Article 5. https://doi.org/10.1371/journal.pone.0284149

Dann, G. M. S., & Seaton, A. V. (2001). Slavery, Contested Heritage and Thanatourism. *International Journal of Hospitality & Tourism Administration, 2*(3–4), 3–4. https://doi.org/10.1300/J149v02n03_01

Darda, K. M., & Chatterjee, A. (2023). The impact of contextual information on aesthetic engagement of artworks. *Scientific Reports, 13*(1), 1. https://doi.org/10.1038/s41598-023-30768-9

Davies, A., Reani, M., Vigo, M., Harper, S., Gannaway, C., Grimes, M., & Jay, C. (2017). Does descriptive text change how people look at art? A novel analysis of eye - movements using data -driven Units of Interest. *Journal of Eye Movement Research, 10*(4), Article Article 4. https://doi.org/10.16910/jemr.10.4.4

Dosovitskiy, A., Beyer, L., Kolesnikov, A., Weissenborn, D., Zhai, X., Unterthiner, T., Dehghani, M., Minderer, M., Heigold, G., Gelly, S., Uszkoreit, J., & Houlsby, N. (2020). *An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale* (Version 2). *arXiv*. https://doi.org/10.48550/ARXIV.2010.11929

Estrada-Gonzalez, V., East, S., Garbutt, M., & Spehar, B. (2020). Viewing art in different contexts. *Frontiers in Psychology, 11*, 569–569. https://doi.org/10.3389/fpsyg.2020.00569

Falk, J. H. (2016). Identity and the Museum Visitor Experience. *Routledge*. https://doi.org/10.4324/9781315427058

Falk, J. H., & Dierking, L. D. (2016). *The Museum Experience Revisited*. Routledge.

Gius, E., Meister, J. C., Meister, M., Petris, M., Gerstorfer, D., Akazawa, M., & Messner, S. (2025). *CATMA* (Version 7.2.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.1470118

Grijzenhout, F. (Ed.). (1999). *The golden age of Dutch painting in historical perspective*. Cambridge University Press.

Henderson, J. M., & Hayes, T. R. (2017). Meaning-based guidance of attention in scenes as revealed by meaning maps. *Nature Human Behaviour, 1*(10), 743–747. https://doi.org/10.1038/s41562-017-0208-0

Hochstrasser, J. B. (2007). *Still life and trade in the Dutch golden age*. Yale Univ.

Itti, L., & Koch, C. (2000). A saliency-based search mechanism for overt and covert shifts of visual attention. *Vision Research, 40*(10–12), 1489–1506. https://doi.org/10.1016/s0042-6989(99)00163-7

JASP Team. (2025). *JASP (Version 0.19.3)* [Computer software]. https://jasp-stats.org/

Kintz, P. (2024). *Text in the Rijksmuseum*. Rijksmuseum. https://books.google.de/books?id=I50M0QEACAAJ

Kret, M. E. (2018). The role of pupil size in communication. Is there room for learning? *Cognition and Emotion, 32*(5), 1139–1145. https://doi.org/10.1080/02699931.2017.1370417

Laeng, B., Sirois, S., & Gredebäck, G. (2012). Pupillometry: A window to the preconscious? *Perspectives on Psychological Science, 7*(1), 18–27. https://doi.org/10.1177/1745691611427305

Land-Zandstra, A. M., Hoefakker, K., & Damsma, W. (2020). Reasoning about Objects in a Natural History Museum: The Effect of Complexity of Questions on Object Labels. *Visitor Studies, 23*(2), Article Article 2. https://doi.org/10.1080/10645578.2020.1781485

Leder, H., Belke, B., Oeberst, A., & Augustin, D. (2004). A model of aesthetic appreciation and aesthetic judgments. *British Journal of Psychology, 95*(4), Article Article 4. https://doi.org/10.1348/0007126042369811

Leinhardt, G., & Knutson, K. (2004). Listening in on museum conversations. *Rowman & Littlefield Publishers*. https://doi.org/10.5771/9780759115521

Lin, F., & Yao, M. (2018). The Impact of Accompanying Text on Visual Processing and Hedonic Evaluation of Art. *Empirical Studies of the Arts, 36*(2), Article Article 2. https://doi.org/10.1177/0276237417719637

Marcom. (2022, November 7). *Home Motivaction EN*. Motivaction. https://www.motivaction.nl/en/

Morris Hargreaves McIntyre. (2015). Culture Segments. *Morris Hargreaves McIntyre*. https://www.mhminsight.com/culture-segments/

Olsen, A., & Matos, R. (2012). Identifying parameter values for an I-VT fixation filter suitable for handling data sampled with various sampling frequencies. *Proceedings of the Symposium on Eye Tracking Research and Applications*, 317–320. https://doi.org/10.1145/2168556.2168625

Pihko, E., Virtanen, A., Saarinen, V.-M., Pannasch, S., Hirvenkari, L., Tossavainen, T., Haapala, A., & Hari, R. (2011). Experiencing Art: The Influence of Expertise and Painting Abstraction Level. *Frontiers in Human Neuroscience*. https://doi.org/10.3389/fnhum.2011.00094

Pilz, Z., Kret, M. E., & Walker, F. (2026). How Child-Friendly Are Art Museums? A Landscape Review of Programs and Initiatives in the 100 Most Visited Art Museums. *Journal of Museum Education*. https://doi.org/10.1080/10598650.2025.2612403

Posit team. (2025). *RStudio: Integrated Development Environment for R* (Version 2025.05.1+513) [Computer software]. Posit Software, PBC. http://www.posit.co/

Rayner, K. (2009). The 35th Sir Frederick Bartlett Lecture: Eye movements and attention in reading, scene perception, and visual search. *Quarterly Journal of Experimental Psychology, 62*(8), 1457–1506. https://doi.org/10.1080/17470210902816461

Reitstätter, L., Galter, K., & Bakondi, F. (2022). Looking to Read: How Visitors Use Exhibit Labels in the Art Museum. *Visitor Studies, 25*(2), 2. https://doi.org/10.1080/10645578.2021.2018251

Rijksmuseum verwelkomt meer publiek dan ooit—Rijksmuseum. (n.d.). Rijksmuseum.Nl. Retrieved January 26, 2025, from https://www.rijksmuseum.nl/en/press/press-releases/rijksmuseum-announces-2019-is-its-most-successful-year-ever

Selvaraju, R. R., Cogswell, M., Das, A., Vedantam, R., Parikh, D., & Batra, D. (2016). *Grad-CAM: Visual Explanations from Deep Networks via Gradient-based Localization*. https://doi.org/10.48550/ARXIV.1610.02391

Sill, G. G. (1996). *A Handbook of Symbols in Christian Art*. Simon and Schuster.

Skov, M., & Kirk, U. (2022). Expertise and Aesthetic Liking. In A. Chatterjee & E. Cardilo (Eds.), *Brain, Beauty, and Art Essays Bringing Neuroaesthetics into Focus.* Oxford University Press.

Smith, J. K., & Smith, L. F. (2001). Spending Time on Art. *Empirical Studies of the Arts, 19*(2), 2. https://doi.org/10.2190/5MQM-59JH-X21R-JN5J

Smith, L. (Ed.). (2011). *Representing enslavement and abolition in museums: Ambiguous engagements*. Routledge.

Theeuwes, J., & Van der Stigchel, S. (2006). Faces capture attention: Evidence from inhibition of return. *Visual Cognition, 13*(6), Article 6. https://doi.org/10.1080/13506280500410949

Tobii AB. (2024). *TobiiProLab* (Version 1.195) [Computer software]. http://www.tobii.com/

Van Der Wel, P., & Van Steenbergen, H. (2018). Pupil dilation as an index of effort in cognitive control tasks: A review. *Psychonomic Bulletin & Review, 25*(6), 2005–2015. https://doi.org/10.3758/s13423-018-1432-y

Villani, D., Morganti, F., Cipresso, P., Ruggi, S., Riva, G., & Gilli, G. (2015). Visual exploration patterns of human figures in action: An eye tracker study with art paintings. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2015.01636

Vogt, S., & Magnussen, S. (2007). Expertise in pictorial perception: Eye-movement patterns and visual memory in artists and laymen. *Perception, 36*(1), 91–100. https://doi.org/10.1068/p5262

Walker, F., Bucker, B., Anderson, N., Schreij, D., & Theeuwes, J. (2017). Looking at paintings in the Vincent Van Gogh Museum: Eye movement patterns of children and adults. *PLoS ONE, 12*, Article e0178912. https://doi.org/10.1371/journal.pone.0178912

Walker, F., Bucker, B., Snell, J., Anderson, N., Pilz, Z., Houwaart, K., Van Den Brink, R., Kintz, P., De Vries, I., &

Theeuwes, J. (2024). Age-adapted painting descriptions change the viewing behavior of young visitors to the Rijksmuseum. *Scientific Reports, 14*(1), Article 22880. https://doi.org/10.1038/s41598-024-73963-y

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Yarbus, A. L. (1967). *Eye Movements and Vision*. US: Springer.