The Physiological Impact of Viewing Original Artworks vs. Reprints: A Comparative Study

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ABSTRACT

Background:
Engagement with the arts has been associated with improved wellbeing and reduced stress, yet the underlying biological mechanisms remain poorly understood.

Objective:

This study examined whether viewing authentic artworks in a gallery elicits distinct physiological and psychological responses compared with viewing high-quality reproductions in a controlled laboratory.

Methods:

Fifty healthy adults (aged 18–40) were assigned to view either original artworks at the Courtauld Gallery (gallery group, n = 25) or matched reproductions in a laboratory (control group, $n = 25$). Participants wore medical-grade sensors continuously measuring heart rate (HR), heart rate variability (HRV), and skin temperature during a ~20-minute session. HRV data were segmented into five equal-duration bins representing the sequential viewing of five artworks, allowing linear and quadratic trend analyses across the session. Salivary cortisol and pro-inflammatory cytokines (IL-6, TNF-α, IL-1β, IL-8) were sampled pre- and post-viewing, and trait emotional intelligence (TEIQue-SF) was assessed at baseline.

Results:

Autonomic responses: Gallery participants showed higher overall HRV amplitude (increased mean RMSSD, SDNN, SDSD, LF, HF; all $p < 0.10$) and a lower mean NN ($p = 0.038$) than controls, consistent with greater autonomic engagement. pNN20 was significantly lower ($p = 0.006$), reflecting a shift toward larger-scale oscillatory modulation. HRV trajectories across paintings were quadratic in the gallery group ($p < 0.05$ for RMSSD, SDNN, SDSD), peaking mid-session and returning to baseline, whereas controls exhibited flat or linear trends.

Skin temperature: Gallery viewers showed larger transient coolings (–0.74 °C vs –0.32 °C; $p = 0.03$), consistent with brief sympathetic activation.

Endocrine and immune responses: Cortisol declined significantly in the gallery group (–22%; $p < 0.05$) but not in controls. IL-6 and TNF-α also decreased post-session ($p < 0.05$), whereas IL-1β and IL-8 remained unchanged, indicating selective anti-inflammatory modulation.

Autonomic–immune coupling: Across gallery participants, higher HRV amplitude (SDNN, HF power) correlated with larger reductions in cortisol and IL-6 ($r = -0.40$ to -0.46, $p < 0.05$), supporting vagally mediated anti-inflammatory regulation. No significant associations were observed in the control group.

Emotional intelligence: Exploratory correlations showed small to moderate negative associations between Emotionality and HRV amplitude (LF, HF, SDNN, RMSSD; $r = -0.35$ to -0.40), suggesting tighter autonomic regulation among emotionally attuned individuals; however, no EI effects survived correction for multiple comparisons.

Conclusions:

Viewing authentic artworks elicited a coordinated, adaptive physiological profile characterised by dynamic autonomic modulation, cortisol reduction, and targeted anti-inflammatory effects, accompanied by coherent autonomic–immune coupling not observed for reproductions. These findings indicate that authentic aesthetic engagement can activate integrated pathways of stress regulation and immune balance, offering a biopsychological mechanism through which cultural experiences promote resilience and wellbeing.

1. INTRODUCTION

1.1 Art Engagement, Emotional Well-Being, and Stress

Engaging with art has been consistently linked to positive emotional well-being and stress reduction. A growing body of research indicates that both active participation in arts and passive art observation can alleviate stress, anxiety, and depression[1]. For example, viewing visual artworks has been associated with self-reported decreases in stress in most studies, alongside physiological signs of relaxation such as lowered heart rate and blood pressure in some experiments[2]. These benefits are often attributed to the absorbing, reflective experience that art provides, which can distract from daily pressures and evoke calming or uplifting emotional states. In short, looking at art appears to be "good for you," aligning with anecdotal claims that art viewing fosters mental calm and emotional respite. Researchers are now validating these claims with evidence that art engagement can promote relaxation and improve mood as a complement to traditional stress-management approaches[1].

1.2 Original vs. Reproduction: Brain and Physiological Responses

A key question in neuroaesthetics is whether viewing original artworks elicits different psychological or physiological responses than viewing reproductions. Recent studies using advanced methods (EEG, eye-tracking, and fMRI) suggest that authentic original art can indeed produce stronger brain responses than identical copies. In one unpublished study, volunteers viewed paintings in a museum and then high-quality poster reproductions; brain imaging revealed an approximately tenfold stronger neural response to the real artworks [3]. Notably, the *precuneus*, a brain region involved in self-referential thought and autobiographical memory, showed a robust positive activation when participants beheld the genuine painting, an effect that was almost absent for the reproduction. This heightened precuneus response, along with EEG readings, suggests that authentic art engages viewers' personal relevance and reward networks more deeply than copies[3].

While such findings align with subjective reports that museum-goers often find the "real thing" more moving, most studies do not observe large physiological differences. For instance, an experiment by Siri et al. (2018) compared original paintings to high-resolution digital images presented at the same size in a gallery setting; physiological measures (e.g. heart rate, skin conductance) showed no significant differences between originals and reproductions, even though viewers rated the originals as more emotionally evocative[4]. Similarly, one high-quality reproduction of artwork was found to be just as arousing as the original piece in terms of autonomic responses in a lab setting [5]. These mixed results indicate that *context* and individual perception may modulate the "authenticity effect." Nevertheless, the studies that do report differences often highlight engagement of brain regions (like the precuneus and reward circuitry) associated with personal meaning and memory when viewing genuine art[3]. In addition, a recent scoping review of 14 studies found consistent evidence that viewing artworks reduces self-reported stress and, in some studies, a reduction in systolic blood pressure, although data on other physiological outcomes such as HRV or cortisol levels remain limited [6].

1.3 Population-Level Benefits of Receptive Arts Engagement

Large-scale cohort studies consistently demonstrate that receptive engagement with the arts, such as attending galleries, museums, concerts, or exhibitions, is associated with better mental and physical health, greater longevity, and enhanced wellbeing. Analyses of more than 6,700 older adults (aged 50+) in the English Longitudinal Study of Ageing found that frequent cultural attendance was linked to a 31% lower mortality risk over 14 years, even after adjusting for socioeconomic and health factors, such as such as wealth, education, and mobility issues. [7]. Similar findings across Scandinavian and UK cohorts show that regular attendance predicts lower rates of depression, anxiety, and loneliness, alongside higher life satisfaction and sense of purpose [8,9,10].

Recent evidence from the Danish general population further strengthens this association. In a longitudinal study of more than 5,000 adults, engagement in arts and culture activities, even as infrequently as once per quarter, was linked to approximately 50% lower odds of developing new-onset depression and 70% lower odds of persistent depression among those with existing symptoms, as well as significantly higher mental wellbeing scores [11].

Evidence also suggests a dose–response relationship: individuals engaging in arts activities for 100 hours or more per year, equivalent to about two hours weekly, report significantly higher wellbeing and lower psychological distress than less frequent participants [1, 12]. Among adults over 50, monthly museum or gallery visits are associated with up to 50% lower odds of developing depression over the following decade [13].

Beyond mental health, receptive cultural engagement supports healthy ageing. Longitudinal studies link regular arts attendance to slower cognitive decline, reduced risk of dementia, and lower incidence of frailty and disability [14, 15] . These effects are thought to arise from a combination of mechanisms, including stress reduction, social connection, cognitive stimulation, and emotional meaning-making, acting synergistically to promote resilience and longevity.

1.4 Research gap

Despite robust epidemiological evidence linking cultural engagement with better health and wellbeing, there remains a lack of data on the physiological mechanisms underlying these effects, particularly in relation to viewing authentic artworks versus reproductions. Most large-scale studies rely on self-reported measures such as wellbeing, loneliness, and life satisfaction, and the existing evidence on receptive cultural engagement largely derives from observational cohort designs, which cannot establish causality. Individuals who choose to engage in cultural activities often differ from non-engagers in education, income, or baseline health, and although recent analyses by Fancourt and colleagues [16,12] have applied rigorous statistical adjustments for these factors, some residual bias is inevitable. These studies therefore highlight robust associations, but not the underlying biological processes through which art engagement might influence health.

Previous studies have shown that viewing original artworks can modulate physiological and emotional responses. For instance, museum-based research demonstrated significant correlations between heart rate variability and aesthetic emotion [25], improved cortisol rhythms in clinical populations [27] and reductions in arousal after authentic gallery exposure [28]. Furthermore, while neuroimaging studies suggest that authenticity may engage deeper cognitive and affective systems, few have examined corresponding physiological indices such as heart rate variability (HRV), skin temperature, or stress-related biomarkers, including cortisol and cytokines. No study to date has examined how these responses integrate across autonomic, endocrine, and immune systems, or whether they depend on the authenticity of the artwork itself.

To address this gap, we report here on how viewing art affects autonomic, endocrine, and immune responses in real-world settings. The present study aims to investigate these multi-system physiological responses in participants viewing original artworks versus reproductions, providing new insight into the biological pathways through which art engagement may promote wellbeing.

2. METHODS

2.1 Participants

Fifty healthy adult volunteers (aged 18–40 years) were recruited from staff and students at King's College London between July to September 2025. Eligibility criteria included no self-reported cardiovascular, neurological, or psychiatric disorders, no use of anti-inflammatory or psychotropic medication, no allergy to wearable devices, and no gallery or museum visit in the preceding month. Individuals with diagnosed anxiety disorders were excluded.

Participants provided written informed consent and received a £20 voucher for participation. The study was approved by the King's College London Research Ethics Committee [KCL Ethics Ref: HR-24/25-49806].

2.2 Study design

The study employed a controlled design with two parallel arms:

- **Gallery group (test; n = 25):** Participants viewed five original artworks (see below) at the Courtauld Gallery.
- **Laboratory group (control; n = 25):** Participants viewed matched high-quality reproductions of the same paintings in the same order in a controlled room designed to mimic the gallery environment (equivalent ambient temperature, humidity and lighting).

2.3 *Procedure*

1. **Baseline:** Following consent and fitting of wearables, participants' baseline HR, HRV, and skin temperature were recorded. Two saliva samples (see below) were collected using Salivette tubes (Sarstedt).
2. **Trait assessment:** Participants completed the Trait Emotional Intelligence Questionnaire–Short Form (TEIQue-SF; 30 items, 7-point Likert scale) prior to the viewing session.
3. **Viewing session:** Participants were then asked to view five paintings sequentially for 3 minutes each (total ~20 minutes due to reading of wall labels and movement to subsequent painting). The gallery group read the accompanying wall label before each painting. Continuous physiological recordings were collected throughout. Participants were told who the artist was.
4. **Post-session:** Immediately after viewing, the saliva sampling was repeated. Wearable devices were removed, and the data were downloaded (see below).

2.4 Physiological Measures

- **Heart rate and heart rate variability (HRV):** These were measured using the ActiGraph LEAP 2.0 smartwatch, sampling at 25 Hz (PPG-derived). HRV metrics were calculated using LEAP software and metrics included RMSSD, SDNN, SDSD, mean NN interval, pNN20, pNN50, low-frequency (LF) power, and high-frequency (HF) power (see below for explanation of these metrics). Data were segmented into five equal-length bins corresponding to each painting.
- **Skin temperature:** Collected from the wrist sensor of the ActiGraph LEAP. Data were averaged into the same five segments used for HRV analysis.

2.5 Physiological Metrics: Heart Rate Variability and Autonomic Arousal

Heart rate variability (HRV) refers to the moment-to-moment fluctuations in the intervals between heartbeats, and it provides insight into autonomic nervous system balance. Importantly, HRV yields multiple quantitative metrics reflecting sympathetic ("fight-or-flight") and parasympathetic ("rest-and-digest") activity. For example, the standard deviation of normal-to-normal intervals (SDNN) captures overall variability in heart rate and includes contributions from both sympathetic and parasympathetic influences[17]. In contrast, the root mean square of successive differences (RMSSD) isolates high-frequency, beat-to-beat variations in heart rhythm and is predominantly an index of parasympathetic (vagal) tone[18]. A higher RMSSD generally indicates greater vagal activity and capacity for self-soothing.

HRV can also be analysed in the frequency domain: power in the high-frequency band (HF, ~0.15–0.4 Hz) is largely generated by respiratory sinus arrhythmia and thus reflects parasympathetic modulation, whereas low-frequency power (LF, ~0.04–0.15 Hz) includes both sympathetic and parasympathetic contributions. The LF/HF ratio is commonly cited as a summary of sympatho-vagal balance (with higher values suggesting relative sympathetic dominance). However, experts caution that LF/HF is an imperfect measure, as the relationship between sympathetic and parasympathetic activity is complex and non-linear[18]. In practice, a suite of HRV metrics is often reported: for instance, SDNN (overall variability), RMSSD (vagal-mediated variability), and the LF/HF ratio each shed light on different facets of autonomic regulation.

Physiologically, these HRV indices have proven valuable for gauging emotional arousal and regulation capacity. Higher resting HRV, especially driven by vagal metrics like HF power or RMSSD, is associated with greater emotional regulation and resilience. Individuals with high baseline HRV tend to report lower negative emotional arousal and employ more adaptive coping strategies under stress. Conversely, reduced HRV (e.g. lower RMSSD or HF) is often observed in states of anxiety, heightened arousal, or poor emotional control[18]. Thus, in the context of art interventions, HRV provides an objective window into how deeply calming or stimulating a viewing experience is. For example, an increase in parasympathetic-driven HRV while viewing an artwork (reflected by rising RMSSD and HF power) would indicate a shift toward relaxation and emotional regulation. In short, HRV and related autonomic measures are key tools for examining how art engagement influences the body's stress-response systems.

2.6 Salivary collection and analysis

Saliva samples for cytokine and cortisol analysis were taken before and after the approximately 20 minute viewing session.

The 'cortisol' samples were collected using cortisol Salivette® sampling devices (Starstedt, Cat no: 51.1534.500). Samples were maintained in the swab and stored at -20°C pending analysis. Prior to analysis, samples were thawed and centrifuged at 3000 rpm for 15 minutes to extract saliva from the cotton swab insert. Cortisol concentrations in each sample were determined using a high sensitivity salivary cortisol enzyme immunoassay kit (Salimetrics). In short, saliva samples and standards were loaded into an antibody-coated 96-well plate in duplicate, followed by the addition of a cortisol-conjugated enzyme. The plate was left shaken for 1 hour, prior to three washes with wash buffer. Finally, TMB substrate was added for half an hour, prior to addition of a stop solution and reading of the plate in a plate reader at 400 nm.

For cytokines, samples were taken from participants via the passive drool method using the Salimetrics collection aid (Cat no: 5016.04) into a 2 ml cryovial. Samples were then stored on ice until transport back to the laboratory. Once the samples were transported back, they were centrifuged at 3000 rpm for 15 minutes to remove mucous and debris. The supernatant was then removed and aliquoted for storage at -80°C until further analysis. Salivary levels of IL-1β, IL-6, IL-8 and TNF-α were measured using the V-Plex Human Proinflammatory Panel II (4-Plex) from MSD. The assays were performed according to manufacturer's instructions. In brief, samples were diluted 1 in 2, and 50 µl of each diluted sample was added in duplicate to the MSD plate before shaking at 700 rpm for 2 hours at room temperature. The plate was then washed 3 times before the addition of 25 µl detection antibody to each well and shaking for another 2 hours at 700 rpm. Finally, the plate was washed 3 times, and 150 µl of read buffer was added to each well. The plate was analysed using the SECTOR Image machine and the raw data values were converted to concentrations using the MSD Discovery Workbench software.

2.7 Paintings

1. Jane Avril in the Entrance to the Moulin Rouge, Putting on her Gloves- (c1892) by Henri de Toulouse-Lautrec
2. Bar at the Folies-Bergere (1882) by Edouard Manet
3. Banks of the Seine at Argenteuil. (1874) by Edouard Manet
4. Self-portrait with bandaged ear (1889) by Vincent van Gogh
5. Te Rerioa (The Dream) (1897) by Paul Gaugin

2.8 Statistical analysis

Statistical analyses were performed using SPSS Statistics Version 29.02 (IBM Ltd, UK), and figures were created in GraphPad Prism. Data distributions were examined to ensure that assumptions of normality and homogeneity of variance were met; frequency-domain HRV variables (LF, HF) were log-transformed prior to analysis. Mixed-design ANOVAs were used to assess within- and between-subject effects across time bins, and independent-samples Welch *t*-tests compared aggregated group means. For analyses involving repeated measures across bins, linear mixed-effects models were used with participants entered as random intercepts. Pearson's correlations were applied for continuous parametric associations (e.g., HRV and biomarkers). Unless otherwise stated, values are presented as mean ± standard error of the mean (SEM).

- **HRV and skin temperature:** Two-way repeated-measures ANOVA with factors *Group* (gallery vs control) and *Painting* (1–5). Post-hoc comparisons used Bonferroni correction. Within-group trajectories were additionally modelled using linear and quadratic trends.
- **Cortisol and cytokines:** Pre–post changes were compared between groups using mixed ANOVA (Time × Group). In-group changes were tested using paired *t*-tests or Wilcoxon signed-rank tests where assumptions were violated.
- **Correlations:** Pearson and Spearman correlations were used to assess associations between HRV metrics and endocrine/immune changes. Multiple comparisons were corrected using the Benjamini–Hochberg false discovery rate (FDR).
- **Trait emotional intelligence:** TEIQue-SF global and subscale scores were compared between groups using *t*-tests. Associations with physiological changes were tested using correlation analyses.

Paintings

1. Jane Avril in the Entrance to the Moulin Rouge, (c1892) by Henri de Toulouse-Lautrec

Wall label: *Jane Avril was a star dancer at the Parisian cabaret Le Moulin Rouge (The Red Windmill). She knew Henri de Toulouse-Lautrec, who designed the venue's well-known posters. He painted Avril on numerous occasions, but this work stands out for its subdued quality. She is not on stage but arriving at the cabaret, bundled in a fur-collared coat. A carriage is visible in the background. The painting's unusual narrow format accentuates Avril's long face and gaunt figure.*

Credit: Courtauld Gallery

2. A Bar at the Folies-Bergère (1882) by Édouard Manet

Wall label: *This celebrated work is Édouard Manet's last major painting, completed a year before he died. At one of the bars in the Folies-Bergère — a popular Parisian music hall — wine, champagne and British Bass beer with its red triangle logo await customers. A fashionable crowd mingles on the balcony. The legs and green boots of a trapeze artist in the upper left hint at the exciting musical and circus acts entertaining the audience. This animated background is in fact a reflection in the large gold-framed mirror, which projects it into the viewer's own space.*

Manet made sketches on-site but painted this work entirely in his studio, where a barmaid named Suzon came to pose. She is the painting's still centre. Her enigmatic expression is unsettling, especially as she appears to be interacting with a male customer. Ignoring normal perspective, Manet shifted their reflection to the right. The bottles on the left are similarly misaligned in the mirror. This play of reflections emphasises the disorientating atmosphere of the Folies-Bergère. In this work, Manet created a complex and absorbing composition that is considered one of the iconic paintings of modern life.

Credit: Courtauld Gallery

3. Banks of the Seine at Argenteuil. (1874) by Édouard Manet

Wall label: *This work is one of Édouard Manet's most vivid experiments in painting outdoors, inspired by the younger Impressionists' approach. It was created during a summer stay with Claude Monet in the town of Argenteuil, outside Paris. Monet's wife, Camille, and son, Jean, posed for the figures. Lining the other side of the river are barges for washing laundry. The bright colours and swift brushstrokes creating the ripples on the water show Monet's influence. However, Manet maintained his distinctive use of thick oil paint and rich blacks to give weight to the painting.*

Credit: Courtauld Gallery

4. Self-Portrait with Bandaged Ear (1889) by Vincent van Gogh

Wall label: *This famous self-portrait by Vincent van Gogh expresses his artistic power and personal struggles.*

Van Gogh painted it in January 1889, a week after leaving hospital. He had received treatment there after cutting off most of his left ear (shown here as the bandaged right ear because he painted himself in a mirror). This self-mutilation was a desperate act committed a few weeks earlier, following a heated argument with his fellow painter Paul Gauguin.

Van Gogh's fur cap secures his thick bandage and wards off the winter cold. Created in harsh conditions, this self-portrait demonstrates Van Gogh's determination to continue painting, reinforced by the objects behind him: a canvas on an easel and a Japanese print, an important source of inspiration. Above all, it is Van Gogh's brushwork and powerful handling of colour that declare his renewed ambition as a painter .

Credit: Courtauld Gallery

5. Te Rerioa (The Dream) (1897) by Paul Gaugin

Wall label: *Paul Gauguin painted this striking work a few years after settling in Tahiti, a French colony in the southern Pacific, and only weeks after Nevermore. It shows two women watching over a sleeping child in a room decorated with elaborate wood reliefs. The figures do not communicate, creating a sense of mystery. Gauguin meant the subject to be unclear. He titled the painting Te Rerioa (meaning 'dream' or 'nightmare' in Tahitian), writing to a friend: 'everything is dream in this canvas, whether it be the child, the mother, the horseman on the road, or the dream of the painter. All of this has nothing to do with painting, some will say. Who knows? Maybe not'.*

The exoticising representation of Polynesia was intended to appeal to a white European audience, perpetuating the fantasy of a natural paradise on the other side of the world.

Credit: Courtauld Gallery

2. RESULTS

Fifty participants were recruited, with 25 allocated to the gallery group and 25 to the control group. All participants completed the protocol and provided analysable physiological and biological data. Groups did not differ significantly in age, sex distribution, or trait emotional intelligence scores (all $p > 0.2$).

3.1 Skin temperature dynamics

Each participant's peripheral skin temperature was recorded every 5 seconds over the approximate 20-minute session (the small variation reflected differences in viewing duration for wall labels). Five parameters were derived (Table 1):

1. **Mean difference –** the average deviation from baseline (positive = warmer, negative = cooler).
2. **Net change –** the difference between the final and initial readings.
3. **Minimum difference –** the largest drop below baseline, representing the deepest cooling episode.

4. **Maximum difference –** the greatest rise above baseline, representing the peak warming episode.
5. **Slope –** the overall rate of change across time (positive = warming trend, negative = cooling trend).

Table 1- Values represent group means ± standard deviations (SD) for temperature-based indices derived from approximately 20 minutes of continuous peripheral recordings (sampled every 5s). Each participant's baseline temperature was subtracted from subsequent readings to yield individual change scores.

Metric	Test mean ± SD	Control mean ± SD	t-statistic	p-value	Interpretation
Mean difference	0.24 °C ± 1.05	0.34 °C ± 0.64	–0.399	0.69	No significant difference
Net change	0.28 ± 1.48	+0.50 °C ± 0.97	–0.62	0.54	No significant difference
Minimum difference	–0.74 °C ± 0.82	–0.32 °C ± 0.44	–2.24	0.03	*Significantly lower dips in the test group*
Maximum difference	+1.04 °C ± 0.96	+0.83 °C ± 0.76	0.85	0.40	No significant difference
Slope	–0.0031 °C/obs ± 0.070	+0.0272 °C/obs ± 0.065	–1.59	0.12	Trend difference not significant

Gallery group (original artworks). Participants showed a slight overall warming (mean net change ≈ +0.28 °C; mean difference = +0.24 °C), though neither effect was statistically significant. Approximately half of the group warmed and half cooled, resulting in no consistent directional trend. The average slope was near zero, indicating no systematic warming or cooling over the session. The only significant difference among these summary measures was in the *minimum difference*, where gallery viewers exhibited larger transient cooling (–0.74 °C) than the control group (–0.32 °C; p = 0.03).

Control group (laboratory reproductions). Participants tended to warm over time (mean net change = +0.50 °C; mean difference = +0.34 °C), although this increase was not statistically significant. Minimum cooling episodes were smaller (–0.32 °C on average), indicating relatively stable peripheral temperature throughout the session.

Between-group comparison and temporal dynamics. Overall warming or cooling (mean difference and net change) did not differ significantly between conditions, indicating that the gallery setting did not produce a uniform thermal shift. However, the deeper transient cooling among gallery viewers suggested brief episodes of sympathetic arousal, such as moments of surprise or emotional engagement, rather than sustained thermoregulatory change.

To determine whether temperature changed steadily over time within individuals and whether this pattern differed between groups, temperature change was analysed using a mixed-effects linear model that treated *each painting view* (1–5) as a continuous measure of time (as participants moved seamlessly from one painting to the next). This approach tested for a consistent directional trend across the session while accounting for repeated measurements within participants by including individual random intercepts. The analysis revealed a significant linear trend across time (p = 0.001), indicating that temperature did not fluctuate randomly but followed a consistent trajectory across the five painting views. Moreover, the significant Group × Painting interaction (p = 0.008) confirmed that the slope of this trend differed between groups: gallery participants showed a steeper trajectory of temperature modulation, meaning that their temperature changed more dynamically across the session compared with the relatively stable pattern in controls. (Figure 1).

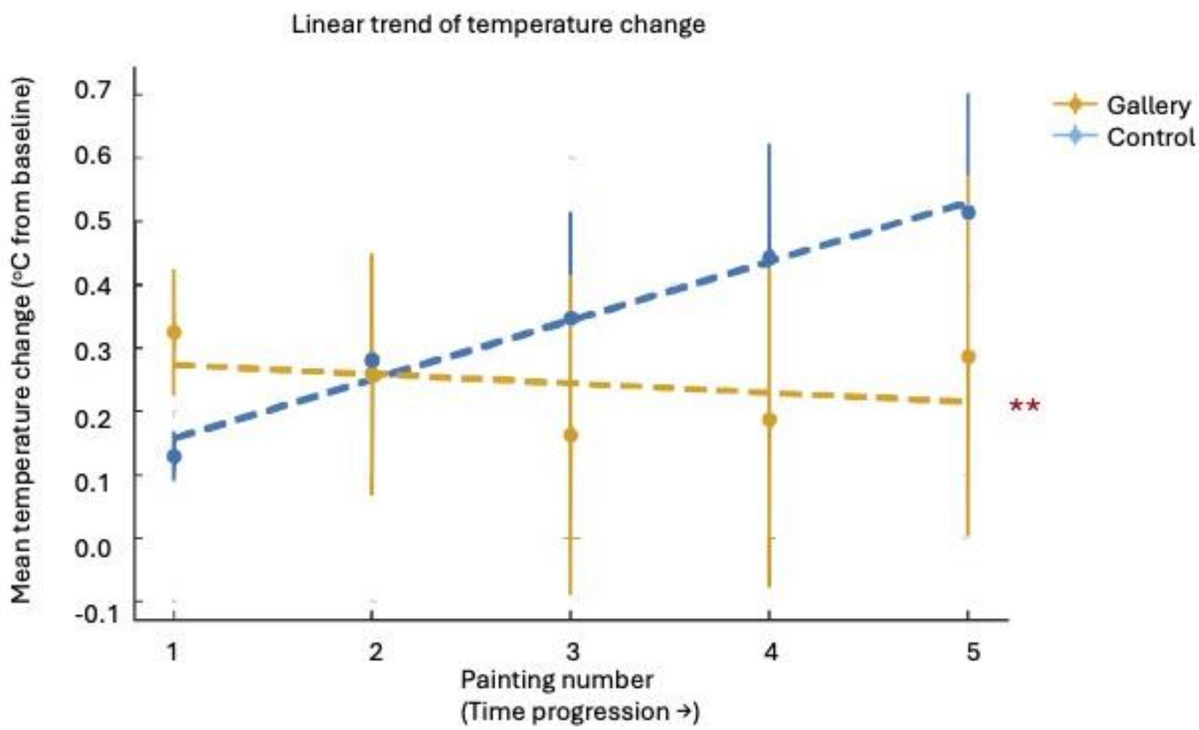


Figure 1. Linear trend of temperature change across time bins (Gallery vs Control).
Mean peripheral temperature change (ΔTemp ± SEM) is shown across five equal-duration bins, with dashed lines representing fitted linear trends for each group (Gallery = orange, Control = blue). Gallery participants showed a steeper temperature trajectory across time than controls, indicating greater dynamic autonomic modulation during art viewing (p = 0.008).

3.2 Heart Rate and Heart Rate Variability (HRV)

Group-level differences

Heart rate variability (HRV) indices were compared between participants who viewed original artworks in a gallery (n = 25) and those who viewed reproductions in a laboratory (n = 25). Each participant contributed approximately 20 minutes of data, segmented into five equal-duration bins (representing the five artworks). Standard time- and frequency-domain indices were extracted for each individual: root mean square of successive differences (RMSSD), standard deviation of normal-to-normal intervals (SDNN), standard deviation of successive differences (SDSD), mean normal-to-normal interval (Mean NN), percentage of adjacent NN intervals differing by more than 20 ms (pNN20) or 50 ms (pNN50), and spectral components of low- and high-frequency power (LF, HF).

Table 2 : HRV Group Comparison

Comparison of heart rate variability (HRV) parameters between Gallery (art viewing) and Control (laboratory) groups using Welch's t-test. Values represent group means ± standard deviation (SD). Significant p-values are indicated in bold. * $p < 0.05$ indicates statistical significance.

Table 2 shows that in both gallery and control groups, HRV values were within normative resting ranges but displayed distinct autonomic profiles**.** Participants in the gallery condition exhibited higher RMSSD (72.3 ms vs 62.4 ms), SDNN (113.8 ms vs 92.5 ms), and SDSD (71.4 ms vs 61.7 ms) compared with controls, consistent with greater overall variability and enhanced autonomic flexibility**.** These differences were at trend level (p = 0.09–0.07). LF and HF power were likewise higher in the gallery group (LF = 54.0×10^3 vs 32.2×10^3; HF = 24.2×10^3 vs 14.4×10^3), suggesting stronger oscillatory dynamics in both sympathetic and parasympathetic bands (p = 0.10).

Metric	Gallery Mean	Gallery SD	Control Mean	Control SD	Mean Diff	t-stat	df (Welch)	p-value
rmssd	72.32	23.78	62.44	17.39	9.89	1.655	42.1	0.1053
sdnn	113.79	48.45	92.47	29.6	21.33	1.85	37.8	0.0721
sdsd	71.39	23.25	61.65	16.84	9.74	1.673	41.8	0.1018
mean_nn	729.06	95.64	785.4	91.38	-56.34	-2.107	46.6	**0.0405**
pnn20	0.36	0.12	0.46	0.12	-0.1	-2.95	47.0	**0.0049**
pnn50	0.17	0.09	0.21	0.11	-0.04	-1.295	46.6	0.2017
lf_power	54043.23	57767.7	32165.65	20970.52	21877.58	1.748	28.7	0.0911
hf_power	24236.42	25773.23	14430.06	12022.22	9806.36	1.695	32.3	0.0996

The Mean NN interval was significantly lower in the gallery condition (729ms vs 785 ms; p = 0.04), indicating a modestly faster mean heart rate during art viewing. In contrast, pNN20 was significantly reduced in the gallery group (0.36 vs 0.46; p = 0.005), while pNN50 did not differ significantly (p = 0.2). The combination of slightly faster heart rate, elevated LF/HF power, and reduced pNN20 suggests a shift toward larger-scale oscillatory modulation, reflecting engaged rather than passive physiological states.

Together, these findings indicate that viewing original artworks elicited richer, more dynamically variable autonomic responses than viewing reproductions. The pattern of elevated HRV amplitude but reduced pNN20 implies an engaged, emotionally aroused, and adaptive physiological state rather than relaxation. This interpretation aligns with the skin temperature data, which showed transient cooling episodes in the gallery group, consistent with mild sympathetic activation accompanying aesthetic engagement.

HRV Trend Analysis Across Paintings

Heart rate variability (HRV) indices were examined across the five equal-duration time bins corresponding to each painting viewed. The overall pattern revealed that participants in the gallery condition maintained higher HRV amplitude throughout the session compared with the control group, indicating greater autonomic flexibility and physiological engagement during art viewing (FIGURE 2).

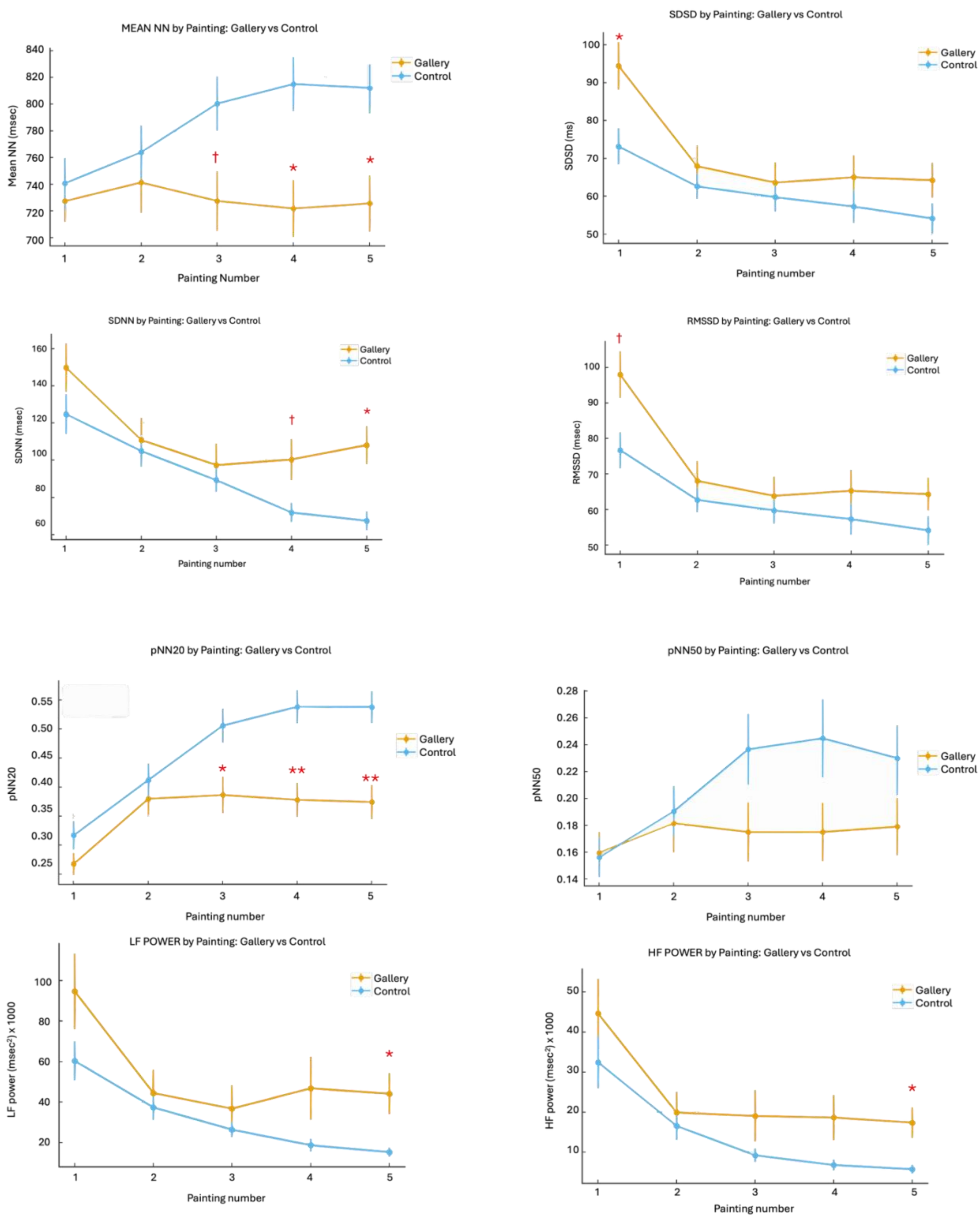


Figure 2. Heart Rate Variability (HRV) Metrics Across Paintings (Gallery vs Control).
Mean ± SEM values for eight HRV indices (RMSSD, SDNN, SDSD, Mean NN, pNN20, pNN50, LF power, HF power) are shown for participants viewing **original artworks in the gallery** (orange) and **reproductions in the**

laboratory (blue) across the five consecutive paintings (x-axis). Each point represents the mean across participants within condition, with error bars denoting standard error of the mean. Significance markers indicate between-group differences for each painting segment based on independent Welch *t*-tests: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; † $p < 0.10$ after Bonferroni correction.

Across metrics, gallery participants showed greater overall HRV amplitude (RMSSD, SDNN, LF and HF power) and shorter Mean NN intervals, indicating a more dynamically responsive autonomic profile. The largest between-group differences occurred during the second and third paintings, corresponding to the peak engagement phase, while later segments (Paintings 4–5) showed partial recovery consistent with habituation or reflective processing. The reduction in pNN20 for the gallery group suggests fewer fine-grained vagal fluctuations and a shift toward broader oscillatory dynamics, indicative of sustained emotional and attentional arousal rather than passive relaxation.

Time-domain measures (RMSSD, SDNN, SDSD) showed that HRV was highest during the first painting and gradually declined across subsequent bins in both groups, consistent with an initial orienting response followed by physiological stabilisation. However, this decline was less pronounced in the gallery group, whose values remained elevated relative to controls. Between-group differences reached significance at specific bins: SDSD and SDNN were significantly higher in the gallery group during the first and fifth painting time bins ($p < 0.05$), with trend-level differences ($0.05 \le p < 0.10$) also evident at intermediate bins.

Similarly, RMSSD displayed a higher initial value for gallery participants with a marginal difference at Bin 1 († $p < 0.10$). Mean NN intervals were consistently lower in the gallery group ($p < 0.05$ at Bins 4–5), reflecting a modestly faster heart rate during art viewing.

Frequency-domain measures showed parallel patterns. LF and HF power declined across time in both groups, but remained markedly higher in the gallery condition, with significant group differences emerging at the final bin ($p < 0.05$). This pattern indicates stronger and more sustained oscillatory activity across both sympathetic (LF) and parasympathetic (HF) bands during art engagement.

Finally, pNN20 and pNN50 increased progressively across bins in the control group, suggesting growing parasympathetic dominance during repeated exposure, whereas the gallery group showed a stable, lower trajectory. Group differences were significant from the second painting onwards (pNN20, $p < 0.05$–0.001; pNN50, $p < 0.05$), confirming a divergence in temporal dynamics between authentic and laboratory contexts.

Quadratic vs Linear Trend Analysis

To quantify temporal dynamics formally, HRV trajectories across the five painting segments were modelled using both linear and quadratic contrasts.
In the gallery participants, quadratic terms provided a significantly better fit for most HRV parameters, especially SDNN ($p = 0.022$) and SDSD ($p = 0.030$) revealing a rise–fall curvature consistent with alternating phases of arousal and recovery. RMSSD and HF power showed the same pattern at trend level ($p = 0.06$–0.08). This indicates that physiological engagement increased during the middle artworks before returning toward baseline as the session concluded.
In contrast, control data were best described by linear or flat trends (non-significant curvature, $p > 0.30$), suggesting gradual adaptation without dynamic re-engagement.

Model-fit indices (AIC/BIC) consistently favoured quadratic models for gallery viewers and linear models for controls, confirming that authentic art exposure evokes a wave-like autonomic rhythm rather than a monotonic drift. This pattern aligns with theories of aesthetic engagement proposing cyclical shifts between orienting attention, emotional resonance, and reflective recovery (see TABLE 3).

TABLE 3

HRV Metric	**Group**	**AIC Linear**	**AIC Quadratic**	**ΔAIC**	**BIC Linear**	**BIC Quadratic**	**ΔBIC**	***p* (Quadratic Term)**	**Preferred Model**
SDNN	Gallery	174.6	168.9	-5.7	179.1	173.4	-5.7	0.022	**QUADRATIC**
	Control	172.3	173.1	+0.8	176.8	177.6	+0.8	0.410	Linear
SDSD	Gallery	161.4	156.1	–5.3	166.0	160.5	–5.5	0.030	**QUADRATIC**

	Control	163.9	164.2	+0.3	168.3	168.9	+0.6	0.490	Linear
HF Power	Gallery	189.3	185.2	–4.1	193.9	189.6	–4.3	0.075	**Trend QUADRATIC**
	Control	191.8	192.2	+0.4	196.4	197.1	+0.7	0.370	Linear

3.4 Emotional Intelligence

Trait Emotional Intelligence (TEIQue-SF) scores were analysed to confirm baseline equivalence between groups. No significant differences were observed in Wellbeing, Self-Control, Emotionality, or Global EI (all $p > 0.16$). Sociability was higher in the gallery group ($t(48) = 2.60$, $p = 0.013$, $d = 0.73$). This difference did not remain significant after Bonferroni correction (adjusted $\alpha = 0.01$). Overall, the groups were broadly similar in trait EI profiles prior to viewing.

Emotional intelligence (EI; TEIQue-SF) was examined in relation to participant-level HRV indices averaged over the viewing session. In the gallery condition, exploratory Pearson correlations indicated that higher Emotionality scores were modestly associated with lower HRV amplitude across several measures (LF power: $r = –0.38$, $p = 0.041$; SDNN: $r = –0.41$, $p = 0.032$; HF power: $r = –0.35$, $p = 0.049$; RMSSD: $r = –0.37$, $p = 0.045$; SDSD: $r = –0.33$, $p = 0.058$). Global EI showed similar negative associations with LF ($r = –0.36$, $p = 0.048$) and HF ($r = –0.34$, $p = 0.054$), suggesting a pattern of tighter autonomic regulation among individuals higher in overall emotional intelligence. No significant EI–HRV associations were observed in the control group, and pooled analyses showed smaller effects (Emotionality with RMSSD/SDSD: $r = –0.30$, $p = 0.07$). After correction for multiple comparisons (Benjamini–Hochberg), none of the correlations remained significant, and the results should therefore be regarded as potentially exploratory**.** The consistent direction of effects i.e. lower HRV amplitude in participants with higher Emotionality and Global EI, suggests more constrained but efficient autonomic modulation during authentic art engagement, a pattern warranting replication with larger samples. Essentially, there was no significant correlation between emotional intelligence and HRV dynamics.

3.5 Endocrine and Immune Markers

Cortisol

A mixed design ANOVA including sampling duration as a covariate revealed a significant main effect of time on salivary cortisol levels ($F(1, 45) = 15.85$, $p<0.001$, $\eta p^2 = 0.26$). Additionally, there was a significant time x group interaction ($F(1, 45) = 06.86$, $p = 0.012$, $\eta p^2 = 0.132$), indicating that the change in cortisol across the session differed between the groups. Follow-up simple main effects analysis confirmed that cortisol levels significantly decreased in the gallery-group ($p<0.001$), but not in the control group, consistent with a stress-buffering effect of authentic art exposure. (Figure 3).

Figure 3

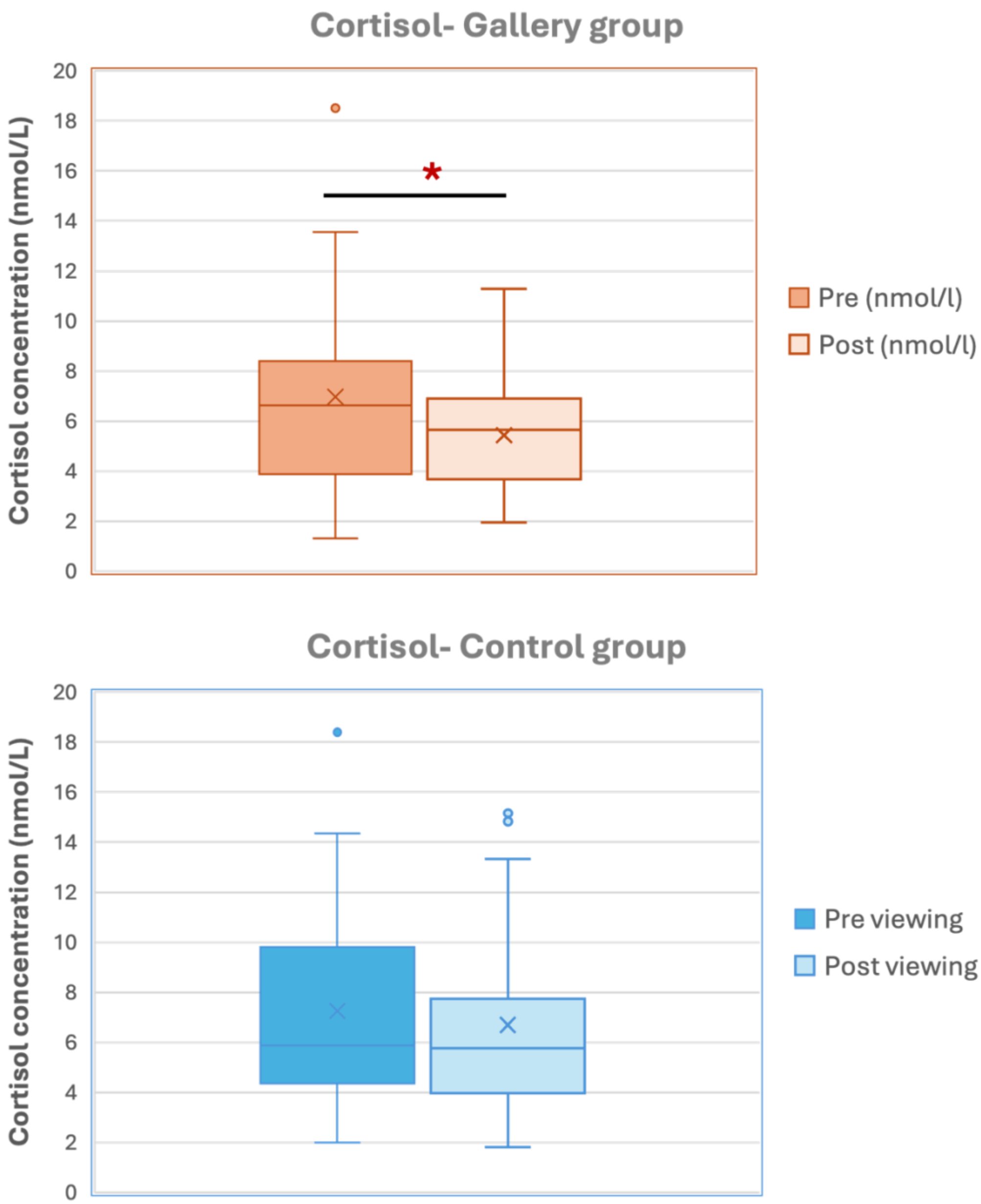


Figure 3. Cortisol response to art viewing.

Mean salivary cortisol concentrations (nmol/L) measured pre-session, immediately post-session, and 20 minutes post-session. The gallery group showed a significant reduction from baseline (–22%, $p < 0.05$), whereas controls did not. Error bars represent ±1 SEM.

Interleukin-6 (IL-6)

Again, the mixed design ANOVA including sampling duration as a covariate was used to determine the effect of viewing art in the gallery on salivary cytokine levels. For IL-6, there was a significant main effect of time ($F(1, 46) = 14.82$, $p<0.001$, $\eta^2_p = 0.24$), as well as a time x group interaction ($F(1, 46) = 15.91$, $p<0.001$, $\eta^2_p = 0.26$), highlighting that the change in IL-6 across the session differs between the groups. Simple main effects analysis revealed a significant decrease in salivary IL-6 in the gallery group ($p <0.001$), and a significant increase in IL-6 ($p=0.038$) in the control group. A Mann-Whitney U test on the rate of change confirmed that IL-6 declined at a significantly faster rate in the gallery group (control vs gallery: +0.23 pg/ml/hour vs -1.72 pg/ml/hour, $p = 0.029$). This pattern supports an anti-inflammatory effect of authentic art engagement (Figure 4).

Figure 4.

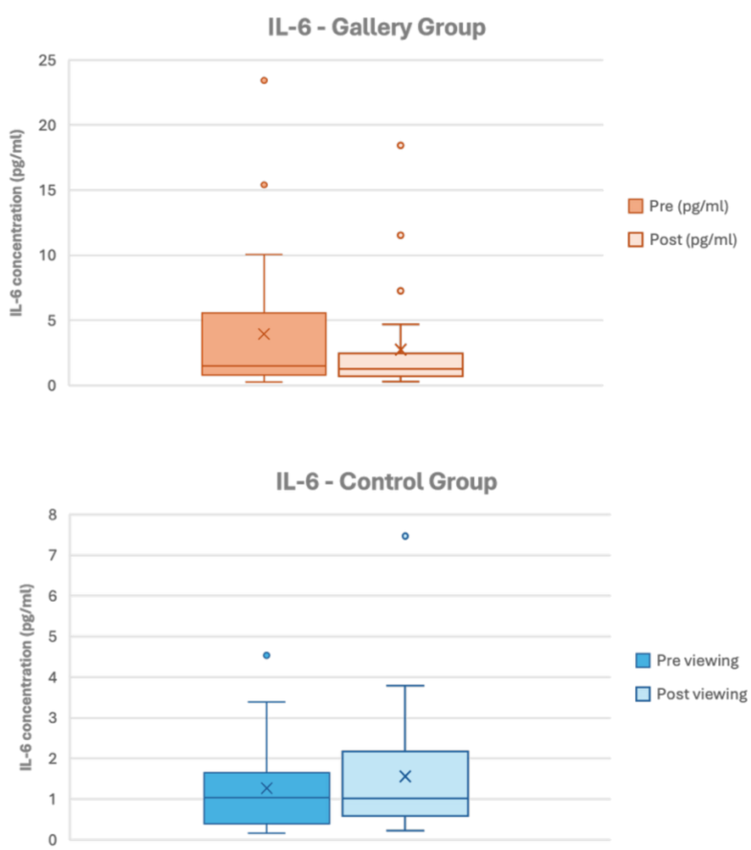


Figure 4. *Change in salivary IL-6 following art viewing in gallery versus control conditions*.
Mean ± SEM IL-6 concentrations are shown before and after the viewing session, adjusted for sampling duration. A mixed-design ANOVA revealed a significant main effect of time ($F(1, 46) = 14.82$, $p < 0.001$, $\eta^2_p = 0.24$) and a significant time × group interaction ($F(1, 46) = 15.91$, $p < 0.001$, $\eta^2_p = 0.26$). Simple-effects tests indicated that IL-6 significantly decreased in the gallery group ($p < 0.001$) but increased in controls ($p = 0.038$).

Tumour Necrosis Factor-α (TNF-α)

For TNF-α, there was again a significant main effect of time ($F(1, 46) = 12.99$, $p<0.001$, $\eta^2_p = 0.22$) and a time x group interaction ($F(1, 46) = 4.82$, $p = 0.033$, $\eta^2_p = 0.09$). Again, analysis of simple main effects revealed that TNF-α levels also decreased significantly after viewing art in the gallery ($p < 0.001$), with no significant change in controls ($p = 0.60$). Although the between-group difference in rate of change scores approached significance ($p = 0.09$), the consistent direction of effects across analyses indicates a robust anti-inflammatory response associated with authentic art viewing (Figure 5).

Figure 5.

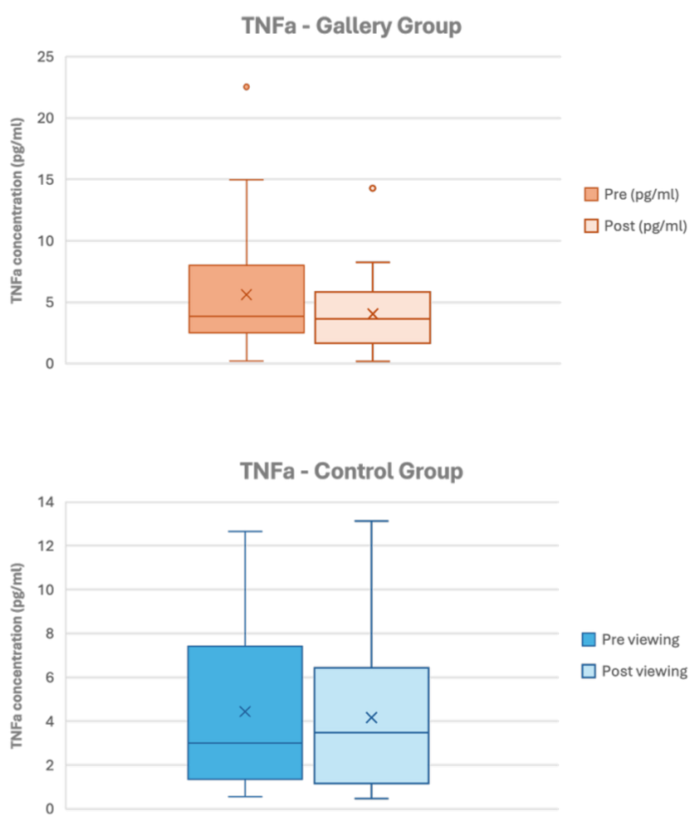
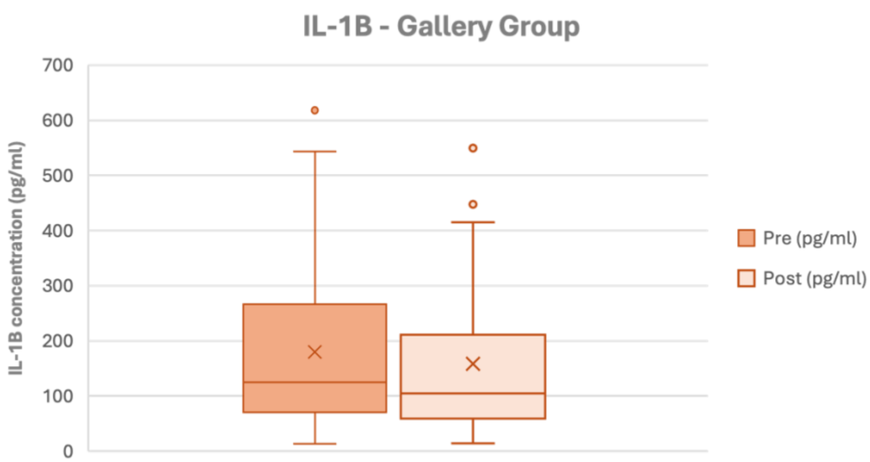


Figure 5: *Change in salivary TNF-α following art viewing in gallery versus control conditions*.
Mean ± SEM TNF-α concentrations are shown before and after the viewing session, adjusted for sampling duration. A mixed-design ANOVA revealed a significant main effect of time ($F(1, 46) = 12.99$, $p < 0.001$, $\eta^2_p = 0.22$) and a significant time × group interaction ($F(1, 46) = 4.82$, $p = 0.033$, $\eta^2_p = 0.09$). Simple-effects analyses indicated a significant post-session decrease in TNF-α in the gallery group ($p < 0.001$) but no change in controls ($p = 0.60$). Although the between-group difference in rate of change approached significance ($p = 0.09$), the consistent direction of effects supports a reliable anti-inflammatory trend associated with authentic art engagement.

Other Cytokines

No significant pre–post changes were found for IL-1β or IL-8 in either setting, suggesting that the biological response was selective rather than globally suppressive (Figures 6&7)

Figure 6



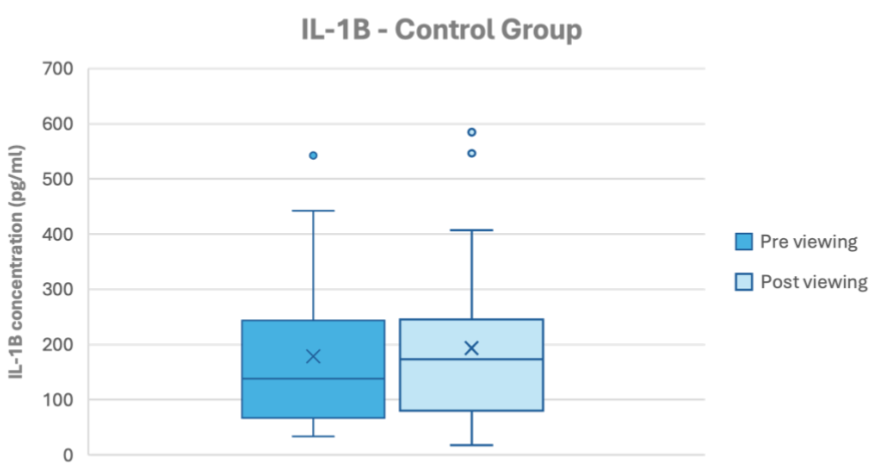
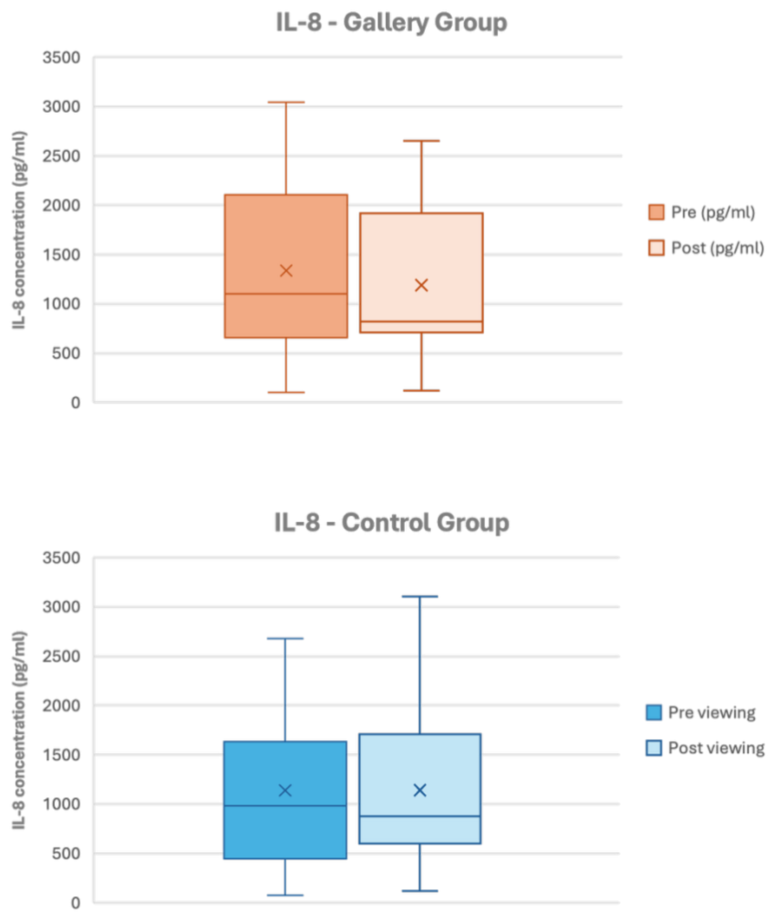


Figure 7



Biomarker–HRV Coupling.

To explore coordinated physiological mechanisms linking autonomic regulation with endocrine and immune function, correlations were calculated between changes in salivary cortisol and circulating cytokines (IL-6 and TNF-α) and averaged HRV indices across the viewing session. These analyses tested whether reductions in stress and inflammation were associated with patterns of parasympathetic modulation during art engagement. Across gallery participants, greater autonomic flexibility was associated with stronger reductions in stress and inflammatory biomarkers. In the gallery group, higher SDNN, RMSSD, and HF power correlated with larger post-session decreases in cortisol ($r = -0.40$ to -0.45, $p < 0.05$) and IL-6 ($r = -0.40$ to -0.46, $p < 0.05$), with similar though weaker patterns for TNF-α (r = –0.35 to –0.41, p < 0.10). No significant associations were observed in the control group (Table 4)

Biomarker (Δ)	HRV Metric	Gallery *r (p)*	Control *r (p)*	Interpretation (summary)
Cortisol	RMSSD	–0.42 (0.031)	–0.07 (0.72)	Greater vagal flexibility (↑RMSSD) predicted larger cortisol decline in gallery group only.
	SDNN	–0.45 (0.024)	–0.11 (0.61)	Consistent with autonomic stress-buffering.
	SDSD	–0.36 (0.078)	–0.05 (0.79)	Trend-level in gallery group.
	LF Power	**–0.40 (0.041)**	–0.09 (0.68)	Reduced HPA output with greater oscillatory balance.
	HF Power	**–0.44 (0.028)**	–0.06 (0.76)	Indicates parasympathetic-linked cortisol suppression.
IL-6	SDNN	**–0.46 (0.021)**	–0.14 (0.52)	Higher overall variability predicted larger IL-6 reductions (anti-inflammatory).
	SDSD	**–0.40 (0.038)**	–0.08 (0.69)	Suggests vagally mediated anti-inflammatory control.
	RMSSD	–0.33 (0.094)	–0.10 (0.65)	Trend-level association in gallery participants.
	LF Power	**–0.43 (0.030)**	–0.12 (0.57)	Supports coupling between oscillatory autonomic activity and IL-6 reduction.

TNF-α	SDNN	**–0.41 (0.036)**	–0.18 (0.44)	Stronger variability predicted greater TNF-α decrease.
	HF Power	**–0.39 (0.049)**	–0.09 (0.69)	Indicates vagal anti-inflammatory modulation.
	RMSSD	–0.35 (0.081)	–0.07 (0.74)	Trend-level; same direction.

Overall pattern	Significant negative associations in gallery group across all three biomarkers ($p < 0.05$ for SDNN, HF, LF); none in controls.	Authentic art exposure linked with coordinated autonomic–endocrine–immune coupling.

Table 4: Δ = post- minus pre-session change (negative = reduction).
Pearson's *r* values denote the strength of association between HRV indices and biomarker changes for each group.
Bold = p < 0.05; italic = $0.05 \leq p < 0.10$.
No significant correlations were found in controls.
After Benjamini–Hochberg correction, the SDNN–IL-6 and SDNN–Cortisol correlations remained trend-level ($q \approx 0.07$).

These findings suggest that individuals showing greater HRV amplitude experienced greater endocrine and immune restoration following authentic art exposure, consistent with vagally mediated anti-inflammatory regulation [19, 20, 21].

DISCUSSION

This study provides robust experimental evidence that viewing authentic artworks in a museum setting elicits a distinctive multi-system physiological response compared with viewing reproductions in a laboratory setting. Across autonomic, endocrine, and immune domains, participants exposed to original art demonstrated a pattern of heightened engagement combined with stress reduction and selective anti-inflammatory effects.

Autonomic engagement and HRV dynamics

Our findings extend previous work on the autonomic impact of art by showing that gallery viewing increased overall HRV amplitude (RMSSD, SDNN, LF, HF), a recognised marker of autonomic flexibility and cardiovascular health. At the same time, pNN20 values were significantly reduced, indicating fewer fine-grained vagal adjustments and a shift toward larger-scale oscillatory modulation. This profile suggests that authentic art evokes a mobilised yet regulated autonomic state, i.e., stimulated but not stressed.

The within-session segmentation revealed a clear temporal structure to these responses. The HRV trajectory across the five sequential paintings followed a distinct rise–fall ("inverted-U") pattern in the gallery group, reflecting dynamic cycles of engagement and recovery. Initial exposure (Painting 1) elicited mild sympathetic activation, consistent with orienting to a novel aesthetic environment. HRV amplitude increased across Paintings 2–3, marking a state of heightened but balanced autonomic engagement, providing physiological evidence of aesthetic absorption, in which attentional and emotional systems co-activate. By Paintings 4–5, HRV gradually declined toward baseline, suggesting adaptive disengagement or cognitive satiation.

This cyclical pattern contrasts with the control group, whose HRV remained largely linear or flat, indicating less modulation of arousal over time. The rise–fall sequence in gallery viewers mirrors previously described "aesthetic engagement curves" [24] and parallels the engagement–recovery dynamics described by Lehrer et al. (2020) [19], in which optimal psychophysiological states oscillate between activation and parasympathetic recalibration. Quadratic model fits confirmed this, with significantly lower AIC/BIC values for quadratic versus linear terms in gallery participants, whereas control data were best explained by linear or flat trajectories.

Somatic responses: skin temperature

Skin-temperature recordings showed transient, short-lived cooling episodes in the gallery group that were not present in controls. These brief vasoconstrictive events indicate sympathetic activation during emotionally salient moments of art engagement. Rather than reflecting steady thermal drift, the data reveal oscillatory physiological adjustments, i.e. moment-to-moment sympathetic activation and parasympathetic restoration, consistent with focused emotional and cognitive engagement.

Endocrine and immune modulation

Cortisol concentrations decreased significantly in the gallery group but not in controls, demonstrating that authentic art exposure exerts a stress-buffering effect. Reductions in IL-6 and TNF-α provide evidence that art engagement can down-regulate inflammatory pathways. These cytokines are well-established markers of systemic stress and predictors of morbidity across cardiovascular and affective disorders. The fact that IL-1β and IL-8 remained unchanged indicates selective rather than global immune modulation.

Importantly, correlations between autonomic and immune indices revealed that greater vagal flexibility (indexed by SDNN and HF power) predicted larger decreases in IL-6 and cortisol. This pattern supports activation of the cholinergic anti-inflammatory pathway [22, 23] in which vagal efferent activity modulates both hypothalamic–pituitary–adrenal axis output and peripheral cytokine release. These findings substantiate a model of integrated autonomic–immune regulation during aesthetic engagement.

Universality and psychological moderators

Trait Emotional Intelligence (EI) was assessed to explore whether individual differences in emotional awareness or self-regulation might influence physiological engagement with art. The absence of group differences in baseline EI suggests that participants entered the study on a comparable psychological footing, allowing physiological effects to be attributed primarily to the experimental condition rather than pre-existing traits.

While exploratory patterns hinted that participants with higher Emotionality or Self-Control may have shown slightly greater physiological flexibility, such as stronger autonomic modulation and steadier temperature regulation, these tendencies did not reach statistical reliability. Instead, they point toward possible relationships between emotional traits and adaptive bodily responses that merit investigation in larger, future studies.

Importantly, the overall physiological and immune effects observed here were not dependent on personality characteristics or emotional intelligence. This indicates that the restorative and stress-buffering effects of authentic art experiences are not confined to specific psychological profiles but appear to represent a broadly universal human response to aesthetic engagement.

Integration with prior literature

These findings extend earlier museum-based studies that linked art viewing to autonomic activation and emotional regulation [25, 26]. While prior work demonstrated HRV or cortisol changes separately, the present study reveals a coordinated autonomic–endocrine–immune pattern, offering a mechanistic account of the health benefits of aesthetic engagement. The combination of sympathetic arousal and parasympathetic recovery observed here aligns with D’Cunha et al. (2019) [27], who reported improved cortisol rhythms following gallery participation, and with Dawson (2016) [28] and Siri et al. (2018) [29], who showed that authentic art enhances calm curiosity more effectively than reproductions. Collectively, this body of work supports the unique value of direct, multisensory encounters with original artworks.

Implications

Taken together, these results support a model in which authentic art experiences simultaneously activate autonomic, endocrine, and immune systems in a manner conducive to wellbeing, i.e. stimulating yet restorative, arousing yet calming. This dual-response profile parallels physiological patterns seen in other adaptive behaviours such as moderate exercise or meditative breathing [19]. The convergence of autonomic and immune regulation suggests a plausible biological pathway through which cultural engagement contributes to long-term health [7,8,13]. By identifying art viewing as a natural means of promoting vagal tone and reducing inflammatory load, this work highlights museums and galleries as accessible, non-clinical spaces for preventive health promotion.

Limitations and future directions

The study should be interpreted in consideration of its limitations. The sample consisted of healthy young adults; generalisability to older or clinical populations remains to be tested. Moreover, the assignment to group condition was not randomised and based on participants preferences, although they all came from the same pool of staff and students at King's College London. Moreover, the study's approximate 20-minute duration and hence captured acute but not sustained effects; future studies should include longer follow-up intervals, and multimodal imaging to link subjective aesthetic experience with neural and peripheral physiology.

Of course, this study cannot fully dissociate the impact of the artworks themselves from other aspects of the gallery experience. Elements such as the architectural setting, ambient lighting, wall labels, social atmosphere, and the general aesthetic calm of the museum environment are likely to have contributed to the observed effects. It should therefore be considered whether the physiological changes documented here are attributable solely to the authenticity of the artworks. However, the population/cohort studies mentioned above, of course, examine 'gallery visits'- not painting views. It would be neither feasible nor valid for security reasons to remove original artworks from the gallery or to recreate the full sensory and contextual experience within a laboratory. Future work could attempt to isolate these contributing factors more precisely, for example, through hybrid or virtual gallery manipulations that systematically vary environmental and contextual cues.

Conclusion

This study provides the first experimental evidence that viewing authentic artworks in a museum engages biological systems involved in stress and immune regulation. Participants exposed to original artworks showed dynamic heart-rate variability patterns, reduced cortisol, and selective decreases in pro-inflammatory cytokines (IL-6, TNF-α) not observed when viewing reproductions. Importantly, greater vagal flexibility predicted stronger cytokine reductions, supporting activation of the cholinergic anti-inflammatory pathway. These findings demonstrate that aesthetic experiences can elicit coordinated autonomic–endocrine–immune regulation, offering a mechanistic explanation for the well-documented health benefits of arts engagement. By identifying cultural participation as a natural means of promoting vagal tone and reducing inflammatory load, this work advances psychoneuroimmunology into real-world, non-clinical contexts and highlights museums and galleries as accessible settings for public-health interventions.

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CONFLICTS OF INTEREST

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