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Emotional Sharing and Heart Rate Synchronization in Joint Art Appreciation: An Exploratory Field Study

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Abstract

Art appreciation is often a collective, embodied process, yet research remains predominantly individual-focused. This study investigates emotional sharing and physiological coordination during joint art exploration in ecologically valid environments. We conducted two art tour studies where small groups explored artworks in culturally meaningful spaces while their emotional states, behaviors, and heart rates were monitored. Results indicate that joint appreciation is a dynamically evolving social process rather than a set of independent reactions. Crucially, dynamics varied by exploration scale: appreciating single, constrained artworks increased interest and stable physiological synchronization, whereas exploring multiple artworks across broader spaces elicited relational affects, such as harmony and gratitude, with fluctuating physiological synchronization patterns. These findings suggest that shared aesthetic experience is an emergent cognitive process shaped by embodied interaction and spatial scale. This research underscores the necessity of field-based, multi-participant approaches to capture the complexity of real-world art appreciation.

Keywords: interpersonal coordination, art appreciation, heart rate synchronization, emotional sharing, embodied cognition, field study

Introduction

The present study focuses on the process by which multiple participants jointly appreciate multiple artworks located within a region characterized by a specific cultural background. We explore, in an exploratory manner, how emotional sharing and physiological coordination—specifically heart rate synchronization—emerge during such collective art appreciation experiences.

Art appreciation can be understood as a process in which viewers exploratorily perceive and cognitively engage with novel spaces, artworks, and their details, thereby generatively constructing new understandings, interpretations, and emotional experiences. This exploratory process should not be regarded as a passive response to external stimuli; rather, it constitutes a dynamically emerged process of meaning-making and emotion that unfolds through viewers' embodied and social activities (Okada & Agata, 2020).

Previous research on art appreciation has predominantly examined situations in which an individual viewer engages with a single artwork, focusing on subjective evaluations, understanding and interpretation, and emotional responses (Leder et al., 2004; Pelowski et al., 2016). These studies have provided valuable insights into intra-individual processes

underlying aesthetic experience. However, in real-world contexts, art appreciation is often an embodied and social activity: it is performed by physically situated individuals, involves concrete bodily actions, and may be carried out together with others. With the exception of a limited number of approaches that emphasize social dialogue—such as Visual Thinking Strategies (Housen, 2002; Yenawine, 2013)—the bodily and social dimensions of shared art appreciation have not been sufficiently examined.

For example, when multiple individuals jointly appreciate a single artwork, additional elements may arise that are absent in solitary viewing. In familiar groups, verbal communication through dialogue is likely to occur, but beyond this, viewers may share gaze, implicitly imitate others' bodily actions such as pointing or tracing artworks (cf. Gallese & Freedberg; Meltzoff, 1995), or subtly adjust their own bodily positions in response to others' postures and locations (cf. Shimizu & Okada, 2025). An illustrative and extreme example can be observed when caregivers visiting an exhibition with infants carried on their backs frequently bend down, change orientation, or move unusually close to artworks in response to the infants' gaze. Such linguistic, nonverbal, and bodily interactions have the potential to transform individual understanding and interpretation, rendering the art appreciation experience more dynamic and collaborative.

Furthermore, in situations where multiple participants sequentially appreciate multiple artworks—often involving substantial movement across a wide spatial area—the diversity of perceptual stimuli and informational input increases. At the same time, the ways in which viewers approach artworks and spaces through bodily actions and exploratory behaviors also become more diverse. Under such conditions, strong overt and covert coupling of behavioral tendencies and physiological responses may emerge within groups that share stimuli and space. These coupled processes may, in turn, support the construction of shared understandings and interpretations (Shimizu et al., 2024).

From this perspective, art appreciation can be reconceptualized not merely as an individual process of forming independent interpretations, emotions, and meanings, but as an emergent process in which understanding, interpretation, and affect are dynamically co-constructed with others through embodied action. This view extends the conception of art appreciation from a static, intra-individual

cognitive process to a dynamic cognitive process that emerges from social and bodily interaction.

Relevant insights can be drawn from studies of collective rituals and performance contexts, such as fire-walking ceremonies and dance appreciation (Konvalinka et al., 2011; Shimizu & Okada, 2024). These studies have demonstrated that heart rate—often regarded as an index of physiological arousal—can become synchronized between performers and observers who share a performance context, and that the degree of such synchronization is related to the quality of the appreciation experience, including evaluative judgments. Although these domains differ from visual art appreciation, they suggest the possibility that similar forms of physiological and emotional synchronization and coordination may also arise among viewers during shared art appreciation and may play an important role in shaping experiential quality.

Building on these considerations, the present study explores emotional sharing and heart rate coordination among multiple participants during joint appreciation of multiple artworks in ecologically valid, real-world contexts. To this end, we designed and conducted art tours in which participants collectively moved through exhibition spaces and environments while appreciating artworks together. Specifically, we examined how sharing exploratory stimuli, spaces, and actions with others gives rise to emotional coupling and physiological coordination, and whether experiences of emotional and physiological connectedness with others are associated with subjective feelings of harmony and pleasantness.

Investigating these processes requires measurement approaches with high ecological validity that capture art appreciation in real-world settings. While laboratory-based approaches are well-suited for isolating causal mechanisms, they are limited in their ability to capture the embodied, social, and cultural dimensions inherent in real art appreciation experiences. Field-based studies conducted in authentic artistic and cultural environments allow for the integrated examination of actual artworks, the cultural contexts surrounding them, extended temporal dynamics of appreciation, and the embodied and social exploratory activities of viewers.

Methods

We conducted two art tour studies that differed in scale and duration. The first tour was conducted on March 5, 2025, in the Ueno Park area in Tokyo, while the second tour took place over three consecutive days (July 16–18, 2025) in the Echigo-Tsumari region of Niigata Prefecture, during the Echigo-Tsumari Art Triennale. Although the duration and spatial scale of the two tours differed, both tours followed a broadly similar structure, as described below.

Participants

Thirteen participants took part in the first tour, and eleven participants participated in the second tour. All participants were full-time employees of advertising-related companies.

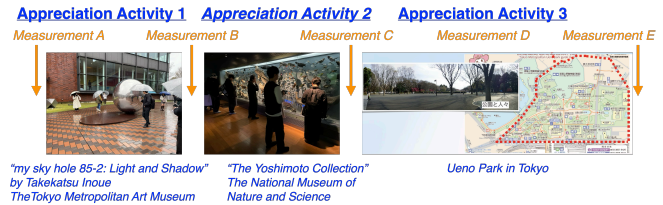


Figure 1. Outline and measurement timing of the first tour

For the Ueno tour, participants included four women and nine men (mean age = 33.93 years, SD = 5.48). For the Echigo-Tsumari tour, participants included three women and eight men (mean age = 32.14 years, SD = 6.51). Participants volunteered and provided informed consent prior to participation.

Procedure

Both tours were structured to gradually expand the spatial and exploratory scope of art appreciation. In each tour, participants first engaged with a single artwork, followed by appreciation of multiple artworks within a broader spatial context. All appreciation activities were conducted in small groups of three to five participants.

First Tour (Ueno) The first tour was conducted over a single day. Participants first (1) appreciated a single artwork—my sky hole 85-2: Light and Shadow by Takekatsu Inoue, located at the Tokyo Metropolitan Art Museum—and shared their impressions within their groups (approximately 50 minutes; Figure 1, left). Next, participants (2) appreciated multiple artworks housed within a single building (the Yoshimoto Collection at the National Museum of Nature and Science) and again shared their impressions within their groups (approximately 60 minutes; Figure 1, right). Subsequently, participants (3) explored the Ueno Park area as a group, engaging in exploratory appreciation of artworks and architectural elements that attracted their interest in the surrounding environment, followed by group discussion (approximately 150 minutes). Finally, participants (4) individually explored a designated building (the International Library of Children's Literature, National Diet Library) and reflected on their experiences from the day (approximately 60 minutes). Phases (1)–(3) were designed to progressively increase the degree of freedom in appreciation—from a single artwork, to a cluster of artworks, and finally to a broader cultural and spatial environment—while encouraging participants to engage in exploratory and agentive appreciation and to share emerging thoughts and emotions with others.

Second Tour (Echigo-Tsumari) The second tour expanded upon the duration and scale of the first tour and was conducted over three days across a wider geographical area. On Day 1, participants (1) sequentially appreciated a single artwork located in Echigo-Tsumari (my sky hole 85-2: Light and Shadow by Takekatsu Inoue) and shared their impressions within their groups. On Day 2, participants (2) freely explored and appreciated multiple artworks distributed

throughout the Echigo-Tsumari region as part of the Echigo-Tsumari Art Triennale, while sharing impressions within their groups. On Day 3, although less directly related to the research questions, participants (3) engaged in collaborative grass-cutting work in terraced rice fields that form part of the exhibition context, together with local residents. In particular, phases (1) and (2) were designed to progressively increase the freedom of exploration and appreciation, from engagement with a single artwork to distributed exploration of artworks embedded within the broader regional environment.

Data Collection

This study examined participants' cognitive, behavioral, and emotional processes during the tours, as well as changes in emotional states and creativity-related measures before and after the tours.

During-Tour Measures During the tours, the following four types of data were continuously or repeatedly recorded: A: Spatial exploration trajectories, measured via GPS data collected from participants' smartphones. B: Objects and events of interest during appreciation activities, recorded via notes or smartphone photographs. C: Intra-group conversations during appreciation activities, recorded using IC voice recorders. D: Emotional states during appreciation and movement, measured using the experience sampling method (ESM) via Google Forms. Emotional measures (D) were based on Russell's (1980) circumplex model and included ratings of valence (pleasant–unpleasant) and arousal (high–low arousal). In addition, participants rated their sense of immersion in the appreciation activity (Csikszentmihalyi, 2009) using five-point Likert scales. Participants also selected applicable emotion labels from a predefined list. In the second tour only, an additional physiological measure was collected: E: Heart rate data, measured continuously during appreciation using a chest-belt heart rate monitor (ECG Move4, Movisens GmbH), to examine inter-participant heart rate synchronization as described in the Introduction.

Pre-and Post-Tour Measures Immediately before and after each tour, participants completed questionnaires assessing their current emotional state, as well as measures related to creativity and social orientation. These included participants' images and attitudes toward artistic activity (Agata & Okada, 2010), openness toward others (Shimizu et al., 2021), perceptions of co-creation with others, and a divergent thinking task (Guilford, 1967). All measures were administered using five-point Likert scales via Google Forms. These measures allowed us to examine changes in emotional states as well as shifts in attitudes and understandings related to creativity and artistic expression across the tours.

Data Collection

This study examined participants' cognitive, behavioral, and emotional processes during the tours, as well as changes in emotional states and creativity-related measures before and after the tours. Given space limitations, the present paper

focuses on three primary analyses: (1) changes in creativity-related attitudes and understandings before and after the tours; (2) intra-individual changes and inter-individual coupling of emotional states during the tours; and (3) inter-participant heart rate synchronization during the tours.

Pre-Post Changes To examine pre-post changes, differences in questionnaire responses before and after the tours were analyzed using linear mixed-effects models. The tour phase (pre vs. post) was treated as a fixed effect (dummy-coded), participants and groups included as random effects, and questionnaire responses served as dependent variables.

Emotional Dynamics During the Tours Individual emotional changes during the tours were examined using emotional ratings collected via ESM. Measurement timing during the tour was treated as a fixed effect (dummy-coded), participants and groups included as random effects, and emotional ratings served as dependent variables. Further, to examine inter-individual emotional coupling, similarity indices were computed for emotional ratings between participants within and across groups. These similarity values were visualized using network representations with nodes and links, allowing extraction and examination of patterns of emotional coupling across participants at each measurement point.

Heart Rate Synchronization and Coordination Inter-participant heart rate synchronization was analyzed following prior studies examining physiological synchronization during collective rituals and competitive dance battles (Konvalinka et al., 2011; Shimizu et al., 2024). Heart rate data were preprocessed through missing-value interpolation and low-pass filtering. R–R intervals were detected and converted to heart rate values (beats per minute; BPM), as illustrated in Figure 2 (left). Heart rate synchronization between pairs of participants was examined using cross-recurrence quantification analysis (CRQA) (Marwan, 2008; Zbilut & Webber, 1998). Heart rate time series were embedded in a reconstructed state space using standard parameter selection procedures. Embedded data from one participant were plotted along the x-axis and those from the other participant along the y-axis, and recurrent points were identified where values fell within a specified threshold. Repeating this procedure across all time points yielded a cross-recurrence plot representing synchronization and coordination between participants (Figure 2, right). From these plots, we extracted recurrence quantification metrics, including Recurrence Rate (RR), representing the proportion of recurrent points; MaxL, representing the maximum length of diagonal lines indicative of sustained synchronization; and L, representing the average diagonal line length. This procedure was applied to all participant pairs within specified conditions to characterize heart rate synchronization patterns. Individual emotional changes during the tours were examined using emotional ratings collected via ESM. Measurement timing during the tour was treated as a fixed effect (dummy-coded), participants and groups included as random effects, and emotional ratings served as dependent variables. Further, to

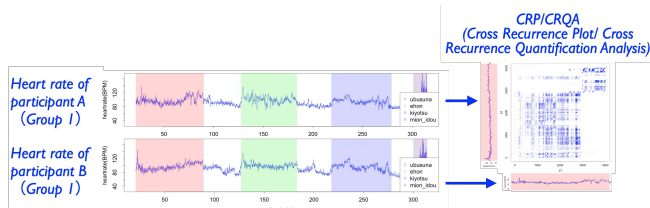


Figure 2. Outline of the heart rate data and synchronization analysis (CRP/CRQA). Precisely, state-space embedding was additionally performed (c.f., Marwan, 2008).

examine inter-individual emotional coupling, similarity indices were computed for emotional ratings between participants within and across groups. These similarity values were visualized using network representations with nodes and links, allowing extraction and examination of patterns of emotional coupling across participants at each measurement point. Three comparison conditions were defined in this study: (1) Intra group condition: participants within the same group, sharing both artworks, space, and direct interaction; (2) Inter group condition: participants from different groups, partially sharing artworks and space without direct interaction; and (3) Virtual group condition: a baseline condition consisting of participants from the same group during different data-collection timing, sharing neither space nor direct interaction. These comparisons allowed us to examine the effects of shared exploratory activity on physiological synchronization.

Results

Pre-Post Changes

Due to page limitations, detailed statistical values are abbreviated. We report the results of pre-post changes and affective dynamics during the Ueno tour data, and the results of heart rate synchronization based on the Echigo-Tsumari tour data; both tours yielded largely comparable results. Figure 3 presents selected results of the pre-post comparisons. Linear mixed-effects models (LMMs) revealed significant fixed effects of time (pre vs. post) for several measures, including interest in art, immersion, openness to others, perceived creativity of others, and perceived creativity through collaboration with others. These results suggest that participation in the tour contributed to changes in participants' motivation toward art and in their understanding of how they relate to and engage with others.

Emotional Dynamics during the Tours

Figure 4 illustrates changes in affective states measured during the tour. Arousal increased after Appreciation Activities 1 and 2, which involved viewing a single artwork or a constrained set of artworks. In contrast, no such increase was observed after Appreciation Activity 3, which involved exploratory appreciation across a broader space and multiple artworks. Valence, by contrast, showed a consistent increase

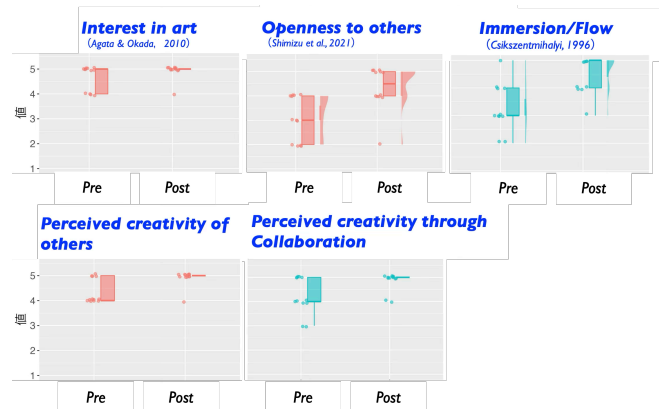


Figure 3. Pre-Post comparison of creativity-related and other-related measures

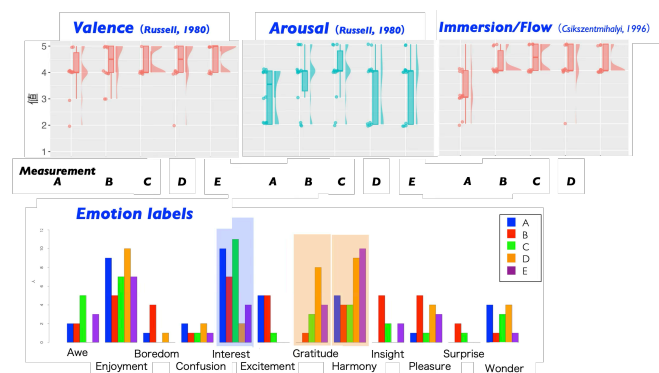


Figure 4. Changes in the affective states of participants

across Appreciation Activities 1–3. As noted above, the significance of these changes across measurement points was confirmed using LMMs. Further, consistent patterns were also observed in the emotion-label reports. After Activities 1 and 2, many participants selected “interest” as their dominant emotion, whereas after Activity 3, a substantial number of participants reported emotions such as “harmony” and “gratitude toward others.” Together, these findings indicate that participants remained engaged and experienced positive affect throughout the tour, while the qualitative nature of affect differed between focused appreciation of specific artworks and broader, exploratory appreciation involving multiple artworks and spaces.

Figure 5 shows the results for affective similarity within and between groups. Although these observations are currently qualitative, arousal levels tended to converge among participants after Activities 1 and 2. In contrast, after Activity 3, some participants—particularly in Groups 2 and 4—exhibited arousal levels that markedly diverged from those of other group members.

Heart Rate Synchronization and Coordination

Figure 6 presents the results of heart rate synchronization during the tour. As shown in the upper panel of Figure 6, during single-artwork appreciation on Day 1 (Activity 1–3), heart rate synchronization was stronger than during transition periods, with relatively uniform distributions indicating

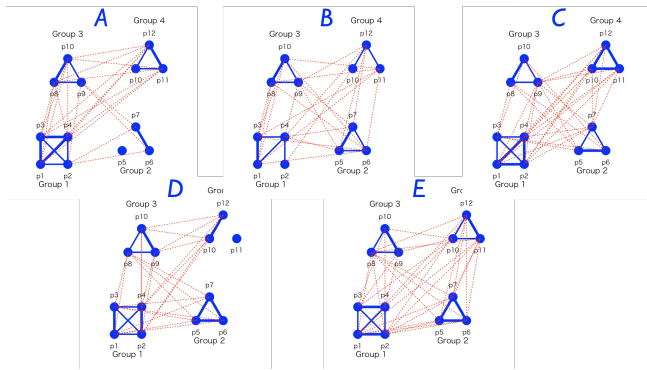


Figure 5. Similarity of the affective states of participants. This figure shows the affective states of arousal. Line thickness represents the degree of emotional similarity between the two individuals

stable synchronization. In contrast, during the free exploration of multiple artworks across a large spatial area on Day 2, periods of strong synchronization alternated with periods showing little synchronization. Condition-based comparisons (Figure 6, lower panel) further showed that on Day 1, within-group heart rate synchronization occurred more frequently than in the virtual baseline condition. On Day 2, within-group synchronization was partially stronger than both between-group and virtual conditions, but also exhibited substantial variability. These results suggest that appreciation involving exploration of multiple artworks across extended spaces is accompanied by fluctuating, rather than stable, patterns of physiological synchronization.

In addition, the present results suggest that the quality of emotional and physiological coordination changes dynamically as the scale of exploration expands across artworks and spaces. Specifically, when participants appreciated a single artwork within a spatially and perceptually constrained context, increases in interest and arousal were pronounced at the intra-individual level, and relatively stable patterns of heart rate synchronization were observed across participants. In contrast, during appreciation of multiple artworks distributed across broader spaces, simple increases in interest or arousal were not consistently observed. Instead, participants reported more frequently relational and affective experiences, such as feelings of harmony and gratitude toward others. At the physiological level, heart rate synchronization in these extended contexts was characterized less by sustained stability and more by dynamic fluctuations, suggesting a more flexible form of coordination.

Discussion

The present study examined the process by which multiple participants jointly appreciate multiple artworks, focusing on intra-individual emotional changes, inter-individual emotional sharing, and physiological coordination as indexed by heart rate synchronization. Our exploratory analyses suggest that shared appreciation of multiple artworks is not reducible to individual emotional responses alone, but can

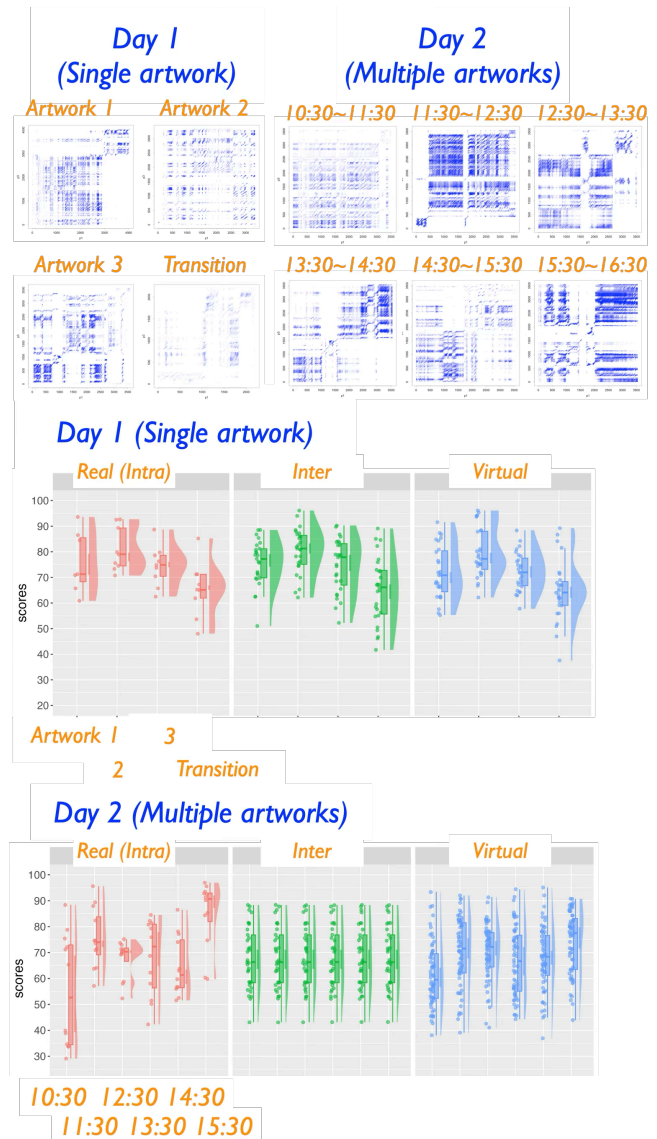


Figure 6. Heart rate synchronization and coordination of participants in the second tour. The upper panel shows the CRP (Cross Recurrence Plot) of a representative pair. The lower panel shows the Quantification indices of the CRP for all pairs in each condition.

instead be understood as a bodily, social, and dynamically unfolding process that involves emotional co-variation and physiological coordination among viewers. These findings complement existing art appreciation research, which has primarily conceptualized appreciation as an intra-individual process of understanding, interpretation, and evaluation, and they point toward the possibility of reconceptualizing art appreciation as an embodied and emergent cognitive process. In addition, the present results suggest that the quality of emotional and physiological coordination changes dynamically as the scale of exploration expands across artworks and spaces. Specifically, when participants appreciated a single artwork within a spatially and perceptually constrained context, increases in interest and

arousal were pronounced at the intra-individual level, and relatively stable patterns of heart rate synchronization were observed across participants. In contrast, during appreciation of multiple artworks distributed across broader spaces, simple increases in interest or arousal were not consistently observed. Instead, participants reported more frequently relational and affective experiences, such as feelings of harmony and gratitude toward others. At the physiological level, heart rate synchronization in these extended contexts was characterized less by sustained stability and more by dynamic fluctuations, suggesting a more flexible form of coordination.

At the same time, the present study is exploratory, and the findings should be regarded as provisional. Future work should increase sample sizes and further analyze additional cognitive and behavioral data collected during the tours, such as GPS-based movement trajectories and photographic records, in order to examine how patterns of change, sharing, and interaction unfold over time. Moreover, combining field-based studies with controlled laboratory experiments that manipulate specific factors would enable a clearer identification of the conditions under which emotional sharing and heart rate synchronization emerge. Such an iterative approach, moving between field and laboratory settings, holds promise for clarifying the causal mechanisms underlying the bodily, social, and dynamic processes observed in shared art appreciation.

Acknowledgments

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