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WHAT DO YOU MEAN WHEN YOU SAY YOU LIKE THIS PAINTING? OCULOMOTOR INDICES OF PROCESSES INVOLVED IN AESTHETICAL APPRECIATION

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This study aims to verify the hypotheses concerning emotional and cognitive predictors of aesthetic judgments, operationalized by instructions for viewing paintings from different perspectives (emotions and feelings, empathy, the captured moment, important elements, title, and mystery). Two eye movement parameters: fixation duration average and scan path length, estimated based on data recorded during viewing paintings, were analyzed. The extent to which the parameters of eye movement while performing different instructions predict the same parameters during the aesthetic assessment task was investigated. It was assumed that similar parameters of eye movements are indicators of similar mental processes, activated under different instructions. The viewing time window and expertise of participants were independent variables. Data were analyzed by multilevel modeling. The results showed that at the early stage of viewing a painting, instructions that activate emotional processing (regardless of expertise), better predict the aesthetic evaluation of a painting than instructions activating

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cognitive processes. At this stage, it was also found that the eye movement parameters, during the performance of instructions that activate cognitive processing, better predict the aesthetic evaluation of paintings only in the group trained in visual arts. At the later stage of viewing paintings, instructions activating cognitive processes turned out to be more reliable predictors of eye movement parameters during the aesthetic evaluation task than instructions activating emotional processes in both groups of participants. The results of the experiment were confronted with the existing models of perception of art and aesthetic experience.

Keywords: aesthetic evaluation; expertise in visual arts; figurative paintings; top-down control of eye movements; multilevel modeling.

In the experiment by Yarbus (1967), only one participant viewed Ilya Repin's "The Unexpected Visitor" for three minutes, performing different instructions. While viewing, the eye movements were recorded. Based on the distribution of the fixation locations on the painting, Yarbus concluded that "depending on the task in which a person is engaged, that is, depending on the nature of the information which must be obtained, the distribution of the fixation locations on an object will vary correspondingly, because different items of information are usually located in different parts of an object" (p. 192). The results of the Yarbus' experiment have been confirmed in several studies (e.g., Betz et al., 2010; Castelhano et al., 2009). Regardless of the changes made to the Yarbus' experiment, all these studies showed significant differences between the parameters of eye movement, depending on the instruction performed.

The results of these studies provoked a question of whether it is possible to predict the task performed by the participant of the experiment based on the parameters of eye movement (an inverse Yarbus process). On the one hand, Greene et al. (2012) stated that while it is possible to predict what kind of image is viewed by static scan paths, it is impossible to predict what type of task is performed. Similar results were achieved by Castelhano et al. (2009) based on summary statistics used for scan path analysis, such as a number of fixations, the mean fixation duration, mean saccade amplitude, or the percent of the image covered by fixations. On the other hand, Borji and Itti (2014) stated that summary statistics are not well suited for implementing an inverse Yarbus process. They proposed an analysis of scanning paths using hidden Markov models or Boosting classifier and obtained results indicating the possibility of predicting the task above a chance level from aggregated eye movement features. Similar results were also obtained in other experiments (e.g., Haji-Abolhassani & Clark, 2014).

Although the results of these studies do not indicate the specific mental processes underlying the trajectory of eye movement recorded during the performance of various instructions, however, their interpretation suggests this possibility. Analyzing the scanning paths recorded by Yarbus can be seen that, under semantically comparable instructions, for example, "tell the age of the people shown in the picture" and "remember the clothes worn by the people in the picture" the scan paths are more similar to each other compared to scan paths under the other instructions. Analogical similarity can be found when comparing the scan paths while following the instructions: "guess what the family was doing before the arrival of the 'unexpected visitor'" and "estimate how long the 'unexpected visitor' had been away from the family." Summarizing the results of their research, Borji and Itti (2014) claim that they provide evidence that fixations are a source of diagnostic information to predict which questions are answered by the subjects while viewing the image. If so, then it may lead to the conclusion that similar mental processes may be responsible for activating specific eye movements during the performance of comparable instructions (e.g., estimating age, search for an object, reading, etc.).

A closer look at these parameters reveals that they are not only different from each other, but also that the range of these differences depends on the instructions, that is, some instructions cause smaller differences between them than others. Even the trajectory of eye movement in the "Free examination" task contains trajectory features recorded when performing other instructions. These observations inspired us to search for answers to the question about deeper motives of differences/similarities between eye movement parameters depending on the instruction. In particular, we addressed this question to the grounds of empirical aesthetics.

The eye movement parameters are the traces of a mental process that precedes an aesthetic evaluation after viewing artwork or performance of other instructions requiring looking at something. Thus, if someone is viewing the same painting several times under different instructions, including the aesthetic evaluation, then from the similarity of the eye movement parameters, one can conclude the correspondence with underlying mental processes.

The Predictors of the Aesthetic Judgment

This study aims to look for the predictors of aesthetic evaluation. We believe that behind aesthetic evaluation, expressed, for example, on the scale "I like—I do not like this painting," there are many different mental processes that influence this evaluation. Based on an extensive literature review, we decided to consider the following six potential predictors of aesthetic evaluation in our research: emotions and feelings, empathy, important elements, title, mystery, and the captured moment. These predictors are certainly not a complete list of possible predictors of aesthetic evaluation, but they are relatively often taken into account in analyses of the conditions of aesthetic experience (Berlyne, 1974; Cupchik, 2016; Pelowski et al., 2017).

Emotions and Feelings

Emotions, feelings or affect are highlighted in almost all theoretical models as undisputed predictors of aesthetic experience (e.g., Cupchik, 2016; Pelowski et al., 2016; Silvia, 2012), both during the early and intermediate visual processing stages (Chatterjee, 2011), as well as during the late processing stages (Leder et al., 2004). Aesthetic emotions include not only pleasure, liking or preference in response to art, but also interest, confusion, surprise, anger, disgust, contempt, pride, shame, and embarrassment (Silvia, 2009). Cupchik (2011) states that "feelings accompany aesthetic experiences from the first moment of their perception" (p. 321).

Empathy

An example of a feeling that appears in an aesthetic context is empathy understood as "the projection of self into the object of beauty" (Jahoda, 2005, p. 154). The concept of aesthetic *Einfühlung* was developed by Lipps (1903). He stated that "while I feel myself active within the perceived figure, I feel myself to be at the same time free, light, and proud. That is an aesthetic imitation, and it is at the same time aesthetic *Einfühlung*" (Lipps, 1903, p. 191). Freedberg and Gallese (2007) argue that "automatic empathetic responses constitute a basic level of response to images and works of art" (p. 202). In one of their experiments, Cupchik and Gignac (2007) asked the participants to justify their choice of two images they liked the most. A number of the recorded statements directly indicated a link between the selected images and the participants' own experiences and emotions (e.g., "…reminds me of the first gang I joined…", "…I have felt the way she is feeling…", "um… well [nervous laughter] this makes me feel uncomfortable…", "…at 24, I still feel like this little kid who has this dream…", "reminds me of my dad… the stuff we did together…", p. 65).

Captured Moment

From rock paintings of animals and people in prehistoric caves to contemporary art, artists have often told stories. The highest development of narrative art dates back to the period between the 17th century and the end of the 19th century (Gombrich, 1995). In ancient Greece and Rome, until the end of the 15th century, events constituting parts of stories were most often depicted together within a single space of a vase, bas-relief, or painting (Small, 1999). Later, painters strived to tell whole stories within a single glance. They tried to freeze the most exciting and intense moments of stories, their climaxes, in paintings (Altman, 2008). Excellent examples of such masterpieces are "The Creation of Adam" by Michelangelo, "Liberty Leading the People" by Eugène Delacroix, or "Girl with a Pearl Earring" by Johannes Vermeer. In the history of art, there are many similar, often extraordinary examples of this type of paintings. However, there is relatively little research in the area of empirical aesthetics concerning the relationship between the way the climax of a story is presented in a painting, and the aesthetic experience (Garwolińska et al., 2018; Waligórska, 2006).

Title

Aesthetic evaluation of a work of art is changing under the influence of additional information (Swami, 2013). The title is one of such contextual guidelines (Gerger & Leder, 2015). However, the results of research on the influence of the title on aesthetic evaluation of a work of art are not consistent. Its mere presence or absence does not necessarily modify appreciation of a work of art. What matters is the way the title is formulated (Bubić et al., 2017), to what extent it expresses the author's intentions (Jucker et al., 2014), what is the level of the participants' expertise (Mullennix & Robinet, 2018), whether it refers to a work of figurative or abstract art (Belke et al., 2010), and what is the experimental design used (within- vs. between-participants) (Russell, 2003). Regardless of the extent to which the title changes the aesthetic judgment of artwork, an attempt to its articulation must be preceded by grasping the meaning or message thereof. According to the models of aesthetic experience, these processes take place at an early stage of perception of a work of art (Leder et al., 2004; Locher et al., 2007; Pelowski et al., 2017).

Mystery

Mystery and ambiguity of a work of art are crucial factors of aesthetic experience (Leder et al., 2004; Pelowski et al., 2017). They trigger the need for understanding (Jakesch & Leder, 2009), interest (Silvia, 2006), surprise and uncertainty (Scherer, 2001), and even excitement (Cupchik, 2016). Moreover, they often constitute marks of successful works (Berlyne, 1974). As noted by Knobloch-Westerwick and Keplinger (2006), high levels of uncertainty and curiosity increase the level of pleasure connected with communing with a mystery and solving it. Cupchik and

Gignac (2007) also stated that mystery is a factor that explains the aesthetic preference of some paintings.

Important Elements

Viewers focus their gaze on faces (Massaro et al., 2012), recognizable objects, or essential elements of a painting composition (Vogt & Magnussen, 2007). The way they select important elements in paintings, and process information contained therein, influences their aesthetic experience at an early stage of perception of an artwork (Leder et al., 2004; Locher et al., 2007; Pelowski et al., 2017).

All the predictors above potentially influence aesthetic evaluation to some extent. They are all theoretically and empirically justified, but the question is, which of them are more and which are less relevant to aesthetic judgment. In this study, we analyze whether the eye movement parameters estimated based on data recorded while viewing paintings under the six mentioned instructions—and which of them—predict the eye movement parameters estimated based on data recorded under the aesthetic evaluation instruction. Emotions and feelings, empathy, and the captured moment predictors form a group of factors relating to the emotional aspect of the aesthetic experience, while the title, mystery, and important elements ones, concern its cognitive aspects. Although the proposed division of the task into two categories in not sharp, we believe that these categories represent the domination of emotional vs. cognitive processes.

Expertise

Expertise is the result of long-term training in a specific field. Knowledge and practical abilities acquired through that training enable experts to deal with complex problems (Bromme et al., 2001). In the domain of art, expertise relates to knowledge of art and, consequently, to different ways of perceiving artworks (Silvia, 2007). Theoretical models and study results suggest that while evaluating an artwork experts focus on the relationships between objects in a painting, its composition, and style.

On the other hand, novices in the field of visual arts pay more attention to the content of the painting and its elements related to emotions (Cupchik, 1994; Leder et al., 2004; Nodine et al., 1993). The novices usually look at selected objects or their parts presented in a painting and then shift their eyesight to other, relatively close ones. This is a local strategy for searching the perceptual field. Experts, on the contrary, look at images globally, shifting their glances from one element to another, often located on the opposite sides of the painting (Locher et al., 2007; Nodine et al., 1993).

The differences between experts and novices in oculomotor behavior were reported in several studies. A meta-analysis of eye-tracking research reveals, for example, that—depending on the characteristics of visualization, tasks, and domain—experts, including art experts (Ylitalo et al., 2016), have shorter fixation duration than novices (Gegenfurtner et al., 2011). Gegenfurtner et al. (2011) also found that, generally, experts in visual tasks made longer saccades. These differences suggest that the level of expertise should be included in research on aesthetic evaluation, as a potential moderator of behaviors while viewing a painting under different tasks.

Viewing Window Time

It is assumed that the aesthetic appreciation of artworks is a dynamic activity that involves different mental processes occurring one after another. The sequence of these processes is described by, for example, the five-stage model of aesthetic appreciation and aesthetic judgments (Leder et al., 2004), or the two-stage model of the relationship between eye movements and visual aesthetics (Locher et al., 2007).

According to these models, the exploration of a painting can be divided into two main parts. At the initial stage (ambient or global), the overall meaning and structure of the painting are captured (Nodine & Krupinski, 2003), and the first affective responses to the painting appear (Locher, 2015). This is the stage of automatic, perceptual, and cognitive analysis of a work of art, including the detection of symmetry, complexity, and groups of elements, their prototypicality, as well as its style and content (Pelowski et al., 2017). During this stage, a global, albeit cursory, analysis of various fragments of the painting takes place; the eye saccades are long, fixations are short (Nodine et al., 1993), and beholders refrain from verbalizing their observations (Locher et al., 2007). The duration of this stage is about two-three seconds from the beginning of the viewing.

In the second stage (focal or local), careful cognitive processing of detailed visual data takes place. Observers focus on different parts of the painting, analyzing their content; eye saccades are shorter, and fixations are longer than in the previous stage (Nodine et al., 1993). The verbal reactions of the observers also begin and are completed within the first seven seconds (Locher et al., 2007). This stage commences about three seconds after viewing onset and lasts for seven seconds or more. The final effect of all these processes is the aesthetic judgment.

Summing up, during both described stages, perceptual and cognitive processes are accompanied by emotional and affective ones. Contemporary models of aesthetic experience suggest that its initial stages are dominated by perceptual processes subordinated to cognition and grasping of the meaning or message of a work of art, and emotions play an essential role only at a later stage of aesthetic evaluation formation (Leder et al., 2004; Locher et al., 2007; Pelowski et al., 2017). On the other hand, Cheung and colleagues (2019) showed that just in the first two seconds from the beginning of viewing the painting, a differentiated emotional reaction of positive or negative valence is revealed, depending on the aesthetic values of the painting. The results of several other studies also indicate the crucial role of emotions in the early stages of aesthetic experience (e.g., Chatterjee, 2011; Cupchik, 2011; Freedberg & Gallese, 2007). So far, the discussion between the two approaches to the role of emotions at different stages of aesthetic experience seems unresolved. Since the models of aesthetic appreciation and aesthetic judgments (Leder et al., 2004) and Vienna Integrated Model of top-down and bottom-up processes in Art Perception (VIMAP) (Pelowski et al., 2017) are more theoretically consistent, we have relied on it to formulate our hypotheses.

Hypotheses

To catch the dynamical aspect of aesthetic evaluations, we analyzed the fixation duration average and scan path length in various time windows. We considered a breakdown of the whole viewing time into three parts: 3 seconds, from 3 to 7 seconds, and from 7 to 15 seconds. The first two time windows are justified under the VIMAP (Pelowski et al., 2017) and the two-stage model of the relationship between eye movements and visual aesthetics (Locher et al., 2007). The last time window represents the later stages of the aesthetic experience. The limitation of the exposure time of the paintings to 15 seconds has been introduced into the procedure because of the results of the pilot studies (see section Procedure). Thus, depending on the viewing time window, the processes involved in the aesthetic evaluation were hypothesized to be predicted (in terms of oculomotor behavior) by different tasks. Namely, we expected that (H1) at the first stage of painting viewing (0–3 s), cognitive processes aimed at understanding a scene depicted in a painting, play a significant role in its aesthetic evaluation (i.e., eye movement parameters estimated based on data recorded during aesthetic evaluation are predicted by eye movement parameters estimated based on data recorded under Important Elements or the Title instructions). According to the model of aesthetic experience (Leder et al., 2004), at the initial stage of viewing the painting, the perception and cognitive processes are triggered automatically, but can be modified by top-down processes as the process develops during the first seconds of viewing. At the second stage of painting viewing

(3–7 s), we also expected that mostly the cognitive processes focused on discovering the deep layers of a scene shown in a painting (under the Mystery instruction), determine its aesthetic evaluation (H2). At the final stage of viewing (7–15 s), based on a cognitive theory of emotions claiming that more complex affective states depend on cognitions (Oatley & Johnson-Laird, 2014), we hypothesize (H3) that emotions dominate mental processes for the final aesthetic judgment (i.e., eye movement parameters estimated based on data recorded under the Aesthetic Evaluation instruction are predicted by eye movement parameters estimated based on data recorded under the Emotions and Feelings, Empathy, and Captured Moment instructions).

Taking into consideration that expertise comes mainly from knowledge about art, we also expected that (H4) participants trained in visual arts would reduce the effects of emotions evoked by the following instructions: Emotions and Feelings, Empathy and Captured Moment, as well as that (H5) trained participants would enhance the effects related to the cognitive processes evoked by the following instructions: Title, Mystery and Important elements.

METHOD

Participants

The experiment was carried out by forty-eight participants. Due to incorrect eye movement records, data of four participants were rejected. Data concerning the remaining forty-four participants (twenty-two females) were classified for analysis. The participants were 20–27 years old (M_{FEMALE} = 23.45 years; SD = 1.53; M_{MALE} = = 23.34 years; SD = 1.73). Based on an online survey, twenty-three participants (eleven females) were assigned to a group with formal education in the art ($M_{TRAINED}$ = 23.91 years; SD = 1.53), and twenty-one (eleven females) were assigned to an untrained group ($M_{UNTRAINED}$ = 22.81 years; SD = 1.54). The group of trained participants included students of the fourth or fifth year of graduate studies (respectively 6 and 13 participants), as well as graduates (5 participants) of art history, painting, or graphics (art history: 20, painting: 3, graphics: 1 participants), declaring an interest in the visual arts. The group of untrained participants included students of cognitive science (8 participants), physiotherapy (1), administration (3), biology (2), psychology (4), law (1), horticulture (2), literature (3) declaring a lack of interest in the visual arts. All participants had a normal or corrected-to-normal vision. They were paid approximately \$10 for their participation in the research.

Stimuli

The paintings used in the experiment were selected using a two-part procedure (see Supplemental Materials). Based on this procedure two beautiful paintings, two paintings regarded as not beautiful and four controversial paintings (equally often indicated as beautiful and as not beautiful) were selected for the experiment. From among the controversial paintings, we chose one more image that we used during the training session (see Supplemental Materials).

Apparatus

The paintings were displayed on NEC SV246 computer screen with 24″ diagonal display and a resolution of 1920 x 1200 pixels. The paintings had an equal height that covered 23.5° of visual angle and variable width between 16.2° and 31.5° of visual angle. The SMI (SensoMotoric Instruments GmbH) RED 500 (sampling rate of 500 Hz) eye tracker was used to record eye movement. A dispersion-based fixation detection algorithm was used with the following parameters: minimum fixation duration = 80 ms, max. dispersion = 100 px. The program for displaying paintings and registering the participants' reactions was developed using PsychoPy, ver. 1.82.00.

Procedure

The experiment was carried out individually. Instructions and paintings were displayed on the computer screen. The participants sat about 65 cm away from the monitor and answered the questions using a keyboard. The experiment duration was about 2 hours on average.

The experiment began with an initial exercise, during which the participants performed the same tasks (instructions) as at the stage of tests. The difference between the initial phase and the test stage was that during the first stage, the participants viewed only one painting that was no longer shown in the test phase, they could ask questions concerning any element of the procedure, and their eye movements were not recorded.

During the test phase, the participant viewed eight paintings (two beautiful, two not beautiful, and four controversial) in random order. After the first painting was drawn (out of eight), the participant got the instruction for viewing it from the aesthetic point of view (see the Aesthetic Evaluation instruction (a) in the "Instructions" section below). Then, the painting was viewed for 15 s, and the participant's eye movements were recorded. After that, the participant made an aesthetic evaluation of it on a 5-point scale (from 1 for *I dislike it very much* to 5 for *I like it very much*). Before the first presentation of each painting, we performed the 5-point eye tracker calibration procedure followed by a 4-point validation. We repeated calibration if validation results were above 1° of visual angle for any of the validation points in the either horizontal or vertical dimension.

The viewing time was limited to 15 seconds because of the pilot study results. We found that experts view paintings for an excessively long time, especially when they have to make an assessment referring to their professional competence. Given that, the participants viewed eight paintings under seven experimental conditions (including reading the instructions before viewing each painting and giving an oral answer to a question asked after viewing it), unlimited viewing time would cause a significant extension of one study, even beyond 4 hours per participant. With a viewing time limit of 15 seconds, the participants had two breaks that lasted several minutes, in order to rest. Also, according to the motivation presented in the theoretical introduction, we were primarily interested in the earlier stages of viewing the paintings.

After the aesthetic evaluation of the painting, the participant got the instruction for viewing the same painting from a specific point of view (one instruction out of six selected randomly; see instructions marked (a) in the section "Instructions" below). Then the painting was viewed for 15 seconds, and the participant's eye movements were recorded. After viewing, he or she received a similar instruction compared to the command he or she had received before viewing the painting and orally responded to a question, or problem suggested therein (see instructions marked (b) in the section "Instructions" below). The statements were recorded.[1] This part of the procedure lasted, on average, about 2 minutes. After the oral statement, another instruction was drawn, and the procedure was repeated until all instructions were completed for the given painting. Then, another painting was drawn that was subject to the participant's aesthetic judgment, and the procedure was repeated until six instructions were completed concerning that painting. The test phase was completed after the execution of all instructions for all the paintings.

[1] In this article the results of the analysis of oral statements are not presented, because its aim is only to verify the hypotheses concerning predictive value of the eye movement during viewing paintings under different instructions. The results of the oral statements analysis have already been published (Francuz et al., 2019).

Instructions

The following instructions were used: (a) before viewing a painting and (b) after viewing it:

(0) Aesthetic Evaluation: (a) "Consider to what extent you like the painting you will see in a moment," (b) "Using the scale, rate the extent to which you like the painting which you have seen. [1] means that you do not like it very much, and [5] means that you like it very much."

(1) Emotions and Feelings: (a) "Think about emotions and feelings evoked by the painting which you will see in a moment," (b) "What emotions and feelings did the painting which you have just seen evoke in you? Please, describe them as accurately as possible."

(2) Important Elements: (a) "Think which elements you consider to be the most important in the painting you will see in a moment. Give reasons for your answer" (b) "What are the most important elements of the painting you have just seen? Give reasons for your answer."

(3) Mystery: (a) "Some works of art conceal mystery. Think about the mystery of the painting you will see in a moment (if applicable)," (b) "What, in your opinion, is the mystery of the painting you have seen (if applicable)? Give reasons for your answer."

(4) Title: (a) "Think about the title you would give to the painting which you will see in a moment in order to most accurately express its meaning" and (b) "How would you entitle the painting you have seen? Why do you consider this title to be the most accurate? Explain."

(5) Captured Moment: (a) "The painting you will see in a moment presents a scene captured by the painter. Think about why the painter chose this moment," and (b) "Why, in your opinion, did the painter of the painting you have seen, choose just this moment. Justify your answer."

(6) Empathy: (a) "Think about whether the scene shown in the painting which you will see in a moment seems close to your personal experience? Think about how you would explain your answer," (b) "Do you think that the scene in the painting you have seen is close to your personal experience? Why do you think so?"

Statistical Analysis

In our study, we asked about the mental processes involved in aesthetic appraisal of paintings. We were interested in verifying which of the six instructions triggered mental processes underlying eye movement while viewing the painting is the most similar to those triggered by the Aesthetic Evaluation instruction. To assess the similarity between tasks we chose the correlational method. One could assume that a strong correlation between repeated measurements suggests a similar process underlying two tasks. Therefore, we carried out hierarchical regression analyses, in which we used average fixation duration and scan path length under the aesthetic evaluation instruction, as dependent variables, and the same set of variables under the remaining six instructions, as predictors. Because we also expected that the level of expertise moderates the association between eye movement during aesthetic evaluation and remaining tasks, we added interaction terms between the expertise level and tasks in the second step of the analysis. As we also hypothesized that mental processes involved in particular instructions are related to aesthetic evaluation in different periods, we performed each of the regression analyses separately for three time windows, that is, between 0 and 3 seconds, between 3 and 7 seconds, and between 7 and 15 seconds.

In our study, we used a repeated measurement approach because each of the participants viewed eight paintings. Thus, data with eight measurements within one participant were used. Because these measurements were nested in two crossing levels, that is, within subjects and paintings, a multilevel modeling approach (MLM) was used, as recommended by Silvia (2007). The primary purpose of the MLM was to decompose the variance of the oculomotor behavior into the variance due to single observations, individual differences as well as variance resulting from viewing different paintings.

Specifying the model involving all possible fixed and random effects (i.e., seven fixed effects for a group and tasks, six fixed interaction effects between group and each of the tasks, two random intercept effects at the subject and the painting cross levels, and twelve random slope effects related to six tasks at the subject and the painting levels) make a risk of a too complex and overestimated model. Therefore, for each of the dependent variables, we carefully tested simpler versions of the full model. In other words, in the first step, we specified the basic model, including seven fixed effects (group and six tasks) and two random intercept effects (for subjects and paintings), and then, we compared these models to the basic model. If the more complex model was better fitted in terms of lower BIC to the basic model, we included the significant additional effects into the second step of regression analysis.

All numerical predictors from the first level were centered to the group mean (i.e., centered within persons). The values of the eye movement variable based on time measurement (i.e., fixation duration) were subjected to logarithmic transformation in order to normalize their distribution. To perform all analyses, we used R software (R Development Core Team, 2008), with lme4 (Bates et al., 2015), sjPlot (Lüdecke, 2020), and MuMln (Barton, 2017) packages.

RESULTS

A summary of the multilevel data analysis results is shown in Table 1. In Table 2, we also presented descriptive statistics for fixation duration and scan path across groups, time windows, and tasks (Table 2).

Table 1

Standardized Beta Coefficients With Standard Errors (in Parentheses) in Multilevel Regression Models for Three Eye-Tracking Measures in Different Time Intervals

Predictors	Dependent variables					
	Averaged fixation duration			Length of scan path		
	0–3 s	3–7 s	7–15 s	0–3 s	3–7 s	7–15 s
Step 1						
Group	.18(.12)	.32(.11)**	.20(.12)	–.06(.09)	–.04(.11)	–.15(.11)
Title	–.07(.08)	.03(.08)	.11(.05)*	.09(.07)	.13(.07)	.21(.07)**
Emotions	.14(.06)*	–.11(.05)*	–.01(.08)	.06(.06)	.03(.07)	.05(.06)
Important element (IE)	–.03(.05)	.05(.05)	–.04(.05)	.05(.07)	.11(.07)	.01(.07)
Mystery	.05(.05)	–.05(.05)	.12(.05)*	.01(.06)	.08(.07)	.15(.07)**
Captured moment (CM)	.07(.05)	.02(.06)	.13(.05)*	.13(.06)*	–.08(.07)	–.05(.07)
Empathy	.01(.05)	.13(.05)**	.05(.04)	.26(.07)***	.03(.07)	.02(.07)
Step 2						
Group x Title	.21(.08)**	ns	ns	ns	ns	ns

Note. ns = nonsignificant effect excluded from the model; interactions of an expertise level (group) with the following tasks: Emotions, Important element, Mystery, Captured moment, and Empathy, were excluded from the model as being nonsignificant.
***$p < .001$, **$p < .01$, *$p < .05$.

Table 2

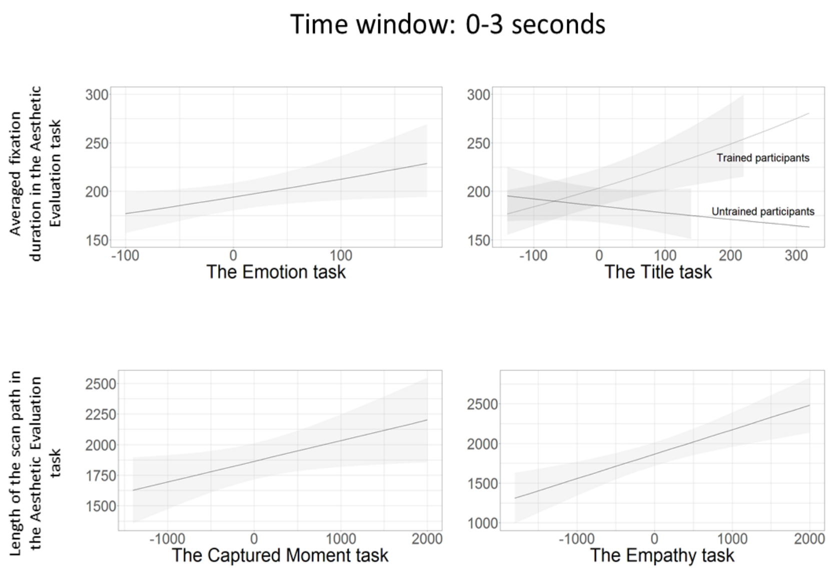
Descriptive Statistic for Fixation Duration and Scan Path Across Groups, Time Windows, and Tasks

		Fixation duration				Scan path			
		Novices		Experts		Novices		Experts	
Task	*Time*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Aesthetic Evalua-tion	0–3 s	184.57	49.47	207.78	64.96	1867.72	712.04	1851.67	766.34
	3–7 s	182.09	52.82	209.52	69.2	2055.36	807.24	2161.19	829.57
	7–15 s	183.48	50.9	216.76	71.08	3966.07	1441.98	3705.09	1468.55
Emotions	0–3 s	196.31	53.73	200.58	62.84	1499.51	667.27	1423.95	622.04
	3–7 s	181.22	45.95	213.43	92.32	1796.23	852.55	1678.29	889.77
	7–15 s	186.75	42.1	207.6	71.45	3566.63	1491.21	3369.3	1356.91
Important Element	0–3 s	183.52	45.93	200.06	62.87	1642.56	691.96	1557.27	658.69
	3–7 s	181.63	39.62	197.62	54.89	1936.27	744.44	1922.8	802.65
	7–15 s	184.53	43.7	207.24	59.16	3673.21	1343.64	3473.33	1383.99
Mystery	0–3 s	184.16	41.05	193.37	58.43	1587.78	674.39	1634.94	662.57
	3–7 s	188.43	56.71	203.03	65.81	1894.82	729.64	1834.64	848.88
	7–15 s	187.66	49.49	202.12	66.29	3438.51	1518.04	3659.36	1452.04
Title	0–3 s	191.12	56.71	205.68	79.35	1558.1	603.47	1474.4	632.06
	3–7 s	182.96	52.78	205.61	80.41	1916.9	701.71	1947.63	876.83
	7–15 s	176.44	43.84	207.85	77.13	3709.12	1462.14	3769.41	1447.91
Captured Moment	0–3 s	194.41	62.41	196.23	56.37	1505.95	706.17	1541.65	617.21
	3–7 s	188.61	61.15	200.99	65.09	1829.21	734.49	1788.41	804.47
	7–15 s	181.78	41.9	199.9	59.25	3537.01	1414.75	3517.55	1251.47
Empathy	0–3 s	187.91	49.48	195.63	57.13	1697.1	737.94	1556.28	765.08
	3–7 s	181.82	42.71	190.51	55.29	1982.22	882.74	1866.36	909.49
	7–15 s	185.39	39.1	204.88	87.86	3870.68	1410.01	3513.7	1526.25

At the very beginning of painting viewing (first 3 s), the following significant effects were observed in all participants (Figure 1). Average fixation duration under the Emotions and Feelings instruction positively predicted average fixation duration under the Aesthetic Evaluation instruction (β = .14, p = .035). Thus, fixation duration under these two conditions changed in a similar way within-person. Also, the effects of scan path under the Captured Moment and Empathy instructions positively predicted the scan path under the Aesthetic Evaluation instruction (β = .13, p = .036, and β = .26, p < .001, respectively). Additionally, expertise moderated the relationship between fixation duration and the task under Title instruction (β = .21, p = .006). Only in the group of trained participants, fixation duration under the Title instruction, predicted fixation duration under the Aesthetic Evaluation instruction (β = .21, p = .059), while in the group of untrained individuals this effect was non-significant (β = –.11, p = .527).

Figure 1

Average Fixation Duration and Length of Scan Path Registered Under Aesthetic Evaluation Instruction (Axis Y) as a Function of Average Fixation Duration and Length of Scan Path (Centered Around Subject's Mean on X Axis) in Emotion, Title, Empathy, and Capture Moment Tasks, in Time Window Between 0 and 3 Seconds

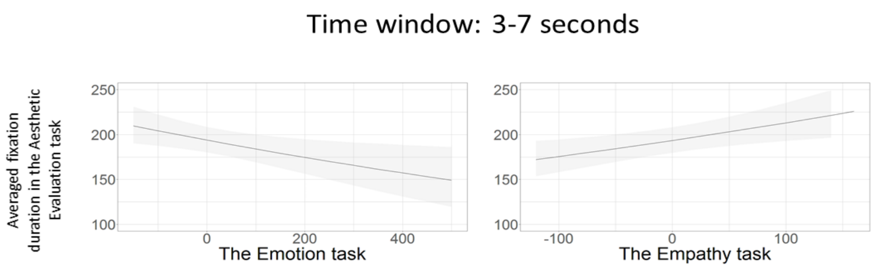


Note. A grey area around the regression lines represents 90% CI of the effect size and the range of the observed scores. Values at the x-axis are centered around a subject mean.

In the middle part of painting viewing (from 3 s to 7 s), the average fixation duration under both the Empathy, as well as Emotions and Feelings instructions predicted the average fixation duration under the Aesthetic Evaluation instruction ($\beta = .13$, $p = .006$, and $\beta = -.11$, $p = .014$, respectively). In this time interval, we also found one main effect related to expertise: trained participants had significantly longer average fixation duration compared to untrained participants ($\beta = .32$, $p = .004$; estimated means = 211 ms and 176 ms, respectively) (Figure 2).

Figure 2

Average Fixation Duration Registered under Aesthetic Evaluation (Axis Y) as Function of Average Fixation Duration (Centered Around Subject's Mean on X Axis) in Emotion and Empathy Tasks, in Time Window Between 3 and 7 Seconds

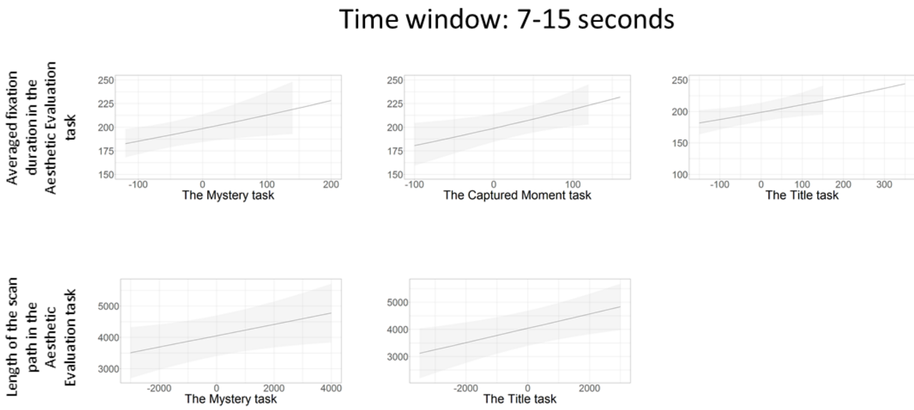


Note. A grey area around the regression lines represents 90% CI of the effect size, as well as the range of the observed scores. Values at the x-axis are centered around a subject mean.

In the final part of painting viewing (from 7 s to 15 s), two instructions predicted scan path under the Aesthetic Evaluation instruction in the whole group: the Title ($\beta = .21$, $p = .005$) and the Mystery ($\beta = .15$, $p = .034$). Additionally, there were significant effects related to average fixation duration under the Title instruction ($\beta = .11$, $p = .018$), the Mystery instruction ($\beta = .12$, $p = .016$), and the Capture Moment instruction ($\beta = .13$, $p = .013$) (Figure 3).

Figure 3

Average Fixation Duration and Length of Scan Path Registered Under Aesthetic Evaluation (Axis Y) as Function of Average Fixation Duration and Length of Scan Path (Centered Around Subject's Mean on the X Axis) in Mystery, Title, and Capture Moment Tasks, in Time Window Between 7 and 15 Seconds



Note. A grey area around the regression lines represents 90% CI of the effect size, as well as the range of the observed scores. Values at the x-axis are centered around a subject mean.

DISCUSSION

This study was aimed at verifying what kind of mental processes are involved in the aesthetic evaluation of a painting. Based on the models of aesthetic experience (Leder et al., 2004), art perception (Pelowski et al., 2017) and the eye movements during an aesthetic experience (Locher et al., 2007), we hypothesized that at the first stage of viewing a painting (i.e., approx. for the first 3 seconds), cognitive processes dominate the aesthetic evaluation of it. Therefore, we expected that parameters of eye movement while viewing a painting under the Title and Important Elements instructions predict them during its aesthetic evaluation. The results did not confirm this hypothesis: within the first 3 seconds of viewing a painting, the average fixation duration under the Emotions and Feelings instruction significantly predicted the average fixation duration under the Aesthetic Evaluation instruction. Moreover, the scan path length under the Empathy and Captured Moment instructions significantly predicted scan path length under the Aesthetic Evaluation instruction.

These effects suggest that during the first few seconds of viewing a painting, people are actively involved in searching for (operationalized by the scan path length) and processing (operationalized by the fixation duration) emotion loaded information marked with Emotions and Feelings instruction. Similarly, Chatterjee (2011) and Cupchik (2011) suggest that emotional processes are triggered while viewing a work of art in the first place. The result is that a significant positive correlation is found between the eye movement parameters during the execution of specific, emotionally marked instructions, and under the Aesthetic Evaluation instruction, regardless of which painting is viewed. Such an outcome may, therefore, imply that during the first three seconds of painting viewing, its aesthetic evaluation is to some extent founded on emotional processes caused by implicit self-instruction directing the observer's attention to detecting his or her affective states related thereto, for example, empathy or climax of the scene presented in the painting (Pelowski et al., 2016).

According to Leder's et al. (2004) and Pelowski's et al. (2017) models, it is assumed that the early processing is mostly automatic; thus, even a top-down regulation related to expertise does not moderate these effects. However, a significant prediction of the average fixation duration at the time of the aesthetic evaluation of painting was observed in the trained—but not in the untrained participants—based on the average fixation duration under the Title instruction. Levinson (1985) defines the title of a work of art as an integral part thereof—an essential property, which plays a crucial role in understanding and interpreting objects that it denotes (p. 29). Therefore, it should not be regarded as an accidental, meaningless expression. Its formulation needs to be abstracted from the part that is the most significant for the painting. It appears that grasping the meaning or message of a painting, although it does not inhibit automatic emotional and self-relevant processes plays an essential role in its aesthetic evaluation from the very beginning of its viewing—but only concerning experts (Mullennix & Robinet, 2018).

At the second stage of painting's viewing (i.e., between 3 and 7s), we expected an enhanced relationship between aesthetic evaluation and cognitive processes captured under the Title and Important Elements instructions, and especially Mystery instruction. This expectation is supported indirectly by the negative relationship between the average fixation duration under the Emotions and Feelings, and the Aesthetic Evaluation instructions. It suggests that the processing of emotional information was inhibited in this time window. On the other hand, we have found that average fixation duration under the Empathy instruction, significantly predicted the average fixation duration under the Aesthetic Evaluation instruction. Although Freedberg and Gallese (2007) claim that empathetic responses are automatic and constitute a basic level of response to artworks, the projection of self into the painting is undoubtedly a task that activates both emotional and cognitive processes (Jahoda, 2005). However, in the analyzed time window, we did not find any effects related to strictly cognitive tasks. We obtained only replications of the other research results, according to which trained participants have significantly longer average fixation duration compared to untrained participants.

Finally, we expected that during the last stage of the aesthetic evaluation of a painting, the participants would reveal a more robust emotional response. Therefore, we hypothesized that at this stage, the Empathy, Emotions and Feelings, and Capture Moment instructions would play a significant role in predicting eye movement parameters during aesthetic evaluation. It was not the case. We observed effects that suggest the dominance of specific cognitive processes involved in aesthetic evaluation during the final stage of painting viewing. The participants would try to discover more profound layers of the scene shown therein. They were mainly the scan path lengths recorded under the Mystery and Title instructions that constituted significant predictors of the scan path lengths under the Aesthetic Evaluation instruction. The Mystery instruction predicted the involvement of deeper cognitive processes engaged during the aesthetic evaluation task (as indexed by the average fixation duration). It suggests that at the last stage of aesthetic evaluation of a painting, people—regardless of their level of expertise—scan the painting, trying to understand its meaning. It is not precisely in line with the dominant models of esthetic experience and art perception (Leder et al., 2004; Pelowski et al., 2017), according to which at a later stage of viewing the painting, emotions, especially aesthetic emotions, rather than cognitive processes, play a crucial role in shaping the final aesthetic evaluation.

LIMITATIONS

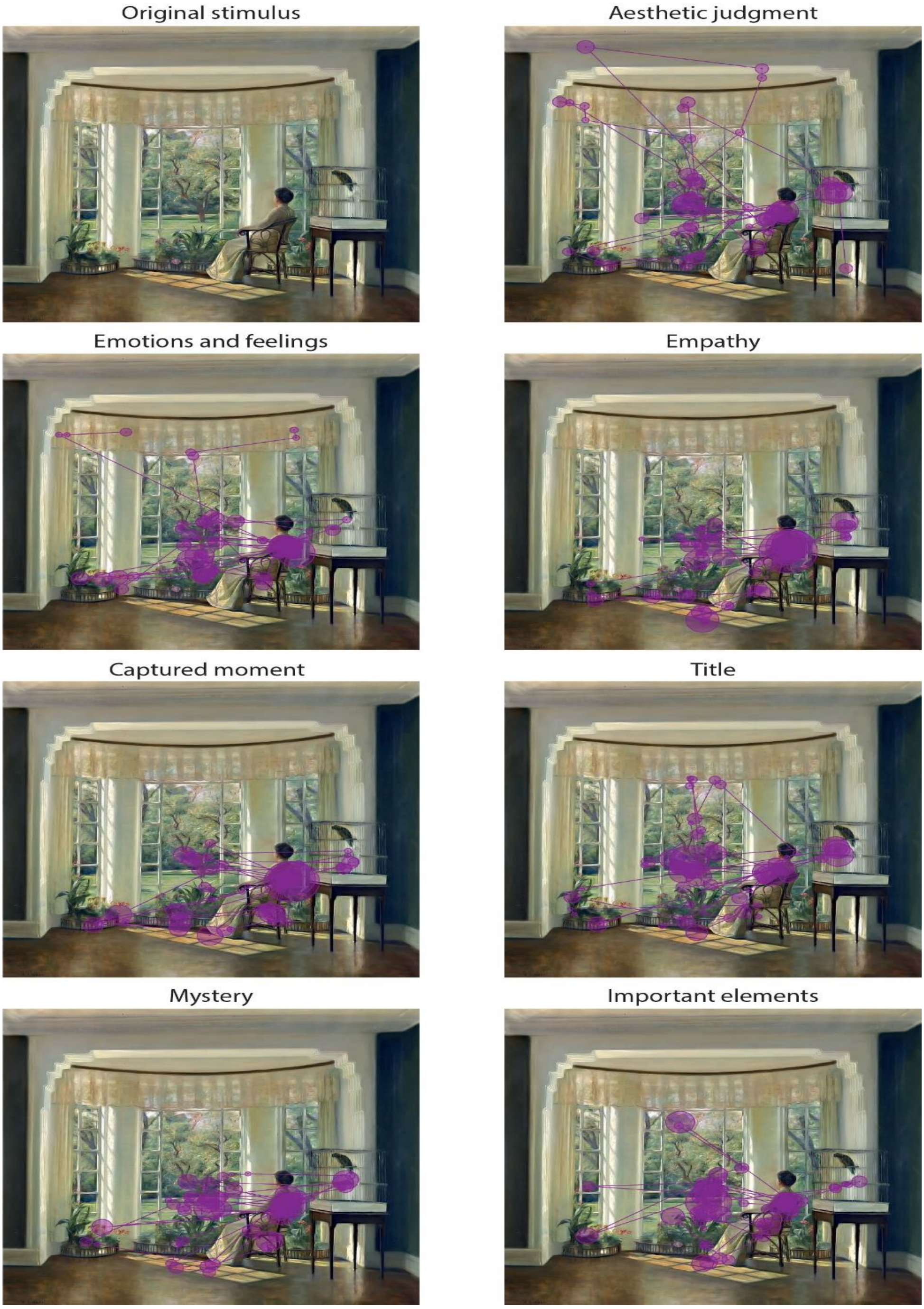
The criticism to the results of these research relates to the extent to which the eye movement during performing instructions aimed at viewing paintings from some perspective, represents the same mental process that is activated during the aesthetic evaluation task. At this stage of research, it is not possible to state it with certainty. Visualization of the similarities between the spatial distribution of fixations in various tasks of our study is depicted in Figures 4 and 5 that show scan path and heatmap visualizations for all experimental tasks, correspondingly.

Figure 4

Heatmaps of Fixations Averaged Across All Participants for Different Tasks

Figure 5

Sample Scan Path Visualizations for One of the Participants for Different Tasks



The limitation of our study is also related to the repetition effect that was present due to the design of the study. Although we tried to reduce it, choosing a proper analysis strategy and randomizing the order of tasks partly, we cannot assume that the repetition effect did not influence the results. Future research should find a solution to the problem of investigating processes engaged in different tasks during viewing the same painting that exclude the repetition effect completely.

CONCLUSION

Considering the results of our research, emotional reactions seem to precede and direct cognitive processes. Discovering the content of an image progresses from recognizing the presented objects and emotional responses that accompany them to discovering hidden, symbolic relations between them. The research paradigm proposed here made it possible to reconstruct this process, although it turned out that not all instructions were equally useful. For example, the Important Elements instruction did not predict any effect under the Aesthetic Evaluation instruction. Further research within this paradigm could move towards testing various other instructions as predictors of aesthetic evaluation of works of art. It would be also interesting to test the interplay between top-down processes relevant to the tasks related to aesthetical evaluation, and the bottom-up processes guided by the features of a painting. Next studies could use computational models based on saliency maps to predict the eye movements and compare them to the scanpaths guided by the top-down processes. However, regardless of the instruction or to what extent it affected eye movement, our research reveals that aesthetic evaluation expressed in a short sentence, such as "I like it" or "I do not like it" is determined by many factors that can be identified by eye movement analysis.

CRediT Author Statement

PIOTR FRANCUZ (60%): conceptualization, methodology, writing (original draft), writing (review and editing), supervision, project administration, funding acquisition.

TOMASZ JANKOWSKI (20%): methodology, formal analysis, writing (original draft), writing (review and editing).

PAWEŁ AUGUSTYNOWICZ (20%): methodology, software, resources, data curation, visualization, writing (review and editing).

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