Is it Art?

Effects of Framing Images as Art Versus Non-Art on Gaze Behavior and Aesthetic Judgments

Frank Papenmeier¹, Gerald Dagit², Christoph Wagner², & Stephan Schwan³

¹ Department of Psychology, Eberhard Karls Universität Tübingen, Germany

² Chair of Art History, Universität Regensburg, Germany

³ Leibniz-Institut für Wissensmedien, Tübingen, Germany

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The data as well as the analysis scripts of the presented experiments are available as open data at: https://osf.io/7ky6d/?view_only=3a92f8f3a78045a7a08b1710b29a1afc

Correspondence concerning this article should be addressed to Frank Papenmeier, University of Tübingen, Department of Psychology, Schleichstr. 4, 72076 Tübingen, Germany. Email: frank.papenmeier@uni-tuebingen.de

Abstract

The perception and evaluation of art might be governed by both stimulus-driven aspects and expectations of the observer. By framing actual artwork and actual scientific depictions as being either artwork or scientific depictions, we were able to investigate the individual contributions of both factors on viewers' gaze behavior and aesthetic judgments. With Experiment 1, we identified a set of images that were equally likely classified as being either artwork or scientific depiction by art laypersons. In Experiment 2, we measured art laypersons' eye-movements as well as their aesthetic judgments regarding those images (half being actual artwork and half being actual scientific depictions). Importantly, we told one group of participants that all images were artwork, whereas we told another group of participants that all images were scientific depictions. Our results indicate that gaze behavior was influenced by the actual image type but not by framing. Actual artwork led to fewer and longer fixations, a shorter scanpath, a shorter distance of fixations to the screen center, and a lower similarity of viewing patterns across participants. Further, actual artwork was rated as being more complex but less meaningful than scientific depictions, with no differences regarding perceived structuredness and liking. Framing the images as artwork led to no changes in perceived meaningfulness, complexity, or structuredness but to lower ratings on liking. We conclude that while the dichotomy between art and non-art influenced art laypersons' gaze behavior and aesthetic judgments, this influence was primarily driven by bottom-up factors rather than a specific cognitive art schema.

Keywords: art, gaze behavior, aesthetic judgments, expectations

Is it Art? Effects of Framing Images as Art Versus Non-Art on Gaze Behavior and Aesthetic Judgments

In 1917, Marcel Duchamp installed an ordinary urinal from a sanitary store at the exhibition of the Society of Independent Artists in New York, provoking a fierce debate on the notion of art. Since then, many modern or contemporary pieces of art – from ready-mades to photographs and abstract paintings – are characterized by an ambiguity about their status as an artwork. Accordingly, "Is it art?" is a question often posed by laypersons confronted with an artifact or image. Since such ambiguous works allow for two mutually exclusive readings – either as a work of art or not – they open a window into the fundamentals of aesthetics. In particular, do the perceptions of the viewers differ if they assume that they are looking at a piece of art instead of a non-artistic image? Following this logic, the present study presented viewers a set of ambiguous abstract paintings and similar looking scientific images and declared them to be either artworks or pictures from scientific publications, thereby investigating the effects of these ascriptions on the viewers' gaze behavior and aesthetic judgments.

Recent models of aesthetic perception and aesthetic judgments assume a close interplay between bottom-up and top-down processes (Leder et al., 2004; Pelowski et al., 2017a); that is, picture processing is not only triggered by the characteristics of a given image – by its basic features like shapes, colors, and formal compositions used to depicted objects, persons, and scenes (Itti & Koch, 2001; Henderson & Hayes, 2017; Greene & Oliva, 2009) – but it is further influenced by the context in which the viewing experience takes place. Regarding works of art, Pelowski et al. (2017b) have compiled a comprehensive list of contextual factors that have empirically been shown to influence art perception. These factors include the institutional context (gallery vs. laboratory setting; Brieber et al., 2015), other artworks in

the immediate surrounding (Koroscik et al., 1992; Tousignant & Bodner, 2018), and the viewing conditions (e.g., viewing distance, Carbon, 2017), among others. They also include the availability of additional information, both in terms of the viewer's art expertise and prior knowledge (Bauer & Schwan, 2018) and in terms of titles or explanations, such as interpretive labels, audio guides, or personal guides (Glaser et al., 2020; Millis, 2001; Schwan et al., 2018).

At the very first stage of art perception, right before a piece of art is looked at, the availability of such information may affect the viewer's pre-classification of the work, which may, in turn, shape his or her subsequent stages of aesthetic processing. For example, paintings are judged to have higher quality and emotional value and are even perceived to be larger in size and spatially closer to the viewer if they have been classified as originals instead of fakes (Seidel & Prinz, 2017; Wolz & Carbon, 2014), and receive higher liking ratings if they are known to be expensive (Lauring et al., 2016). But beforehand, the most fundamental classification of art perception has to be made, namely, whether a certain object is considered a work of art at all. This is by no means a simple task because art is an inherently ambiguous term that has been defined intensionally along various dichotomies. A piece of work may be judged to be art if it possesses certain formal characteristics, has been produced with an artistic intention, evokes aesthetic reactions, serves particular functions, relates to previous artworks, belongs to certain institutions (like art galleries), or has been declared art by authorized representatives of the art world (Hayn-Leichsenring, 2017). Accordingly, the very same object may be either classified as art or not, depending on its attributes, circumstances of presentation, and criteria applied. This ambiguity is particularly evident for various types of modern and contemporary art, like land art, ready-mades, hyperrealistic paintings, or art photography.

The ambiguity of works of art has also been demonstrated empirically. In a study by Pelowski et al. (2017b), viewers were shown a large sample of works of art as well as a control set of non-art objects and were asked to classify them as art or non-art. The authors found that participants often did not classify works of art as art. This was true for hyperrealistic paintings and for ready-mades, which were considered art in less than 50% of the cases, but – albeit to a much lesser extent – even for Renaissance or Baroque paintings. For the present study, the classification of abstract paintings is of particular relevance. In the Pelowski et al. (2017b) study, on average about a quarter of the abstract paintings presented was not considered art by lay viewers. Similarly, Snapper et al. (2015) found that lay viewers mistook abstract art for works by children or animals in about one third of the cases.

Classifying a given object either as art or non-art may, in turn, evoke different kinds of cognitive schemas. More specifically, it has been argued that judging a piece of work as art activates an art schema that guides a specific mode of perception (Wagner et al. 2014). An art schema is based on the assumption that art differs from everyday-life stimuli in several aspects. Art does not serve immediate pragmatic goals, does not require immediate reactions to cope with risks, and is expected to convey a deeper meaning, to be cognitively challenging, and to go along with aesthetic pleasure (Gerger et al., 2014; Wagner et al., 2014). In consequence, activation of these art related expectations is assumed to have a profound effect on mental processing. In particular, due to the expectation of deeper meaning, art should be looked at more intensively and be processed more elaborately (Hayn-Leichsenring, 2017; Pelowski et al., 2017b). Additionally, viewers should attend not only to its content but also to stylistic and formal properties, which allows them to tolerate semantic and syntactic inconsistencies and to enjoy ambiguous, negative, or provocative works of art (Pelowski et al., 2017b).

Several studies have tested these assumptions by declaring sets of pictorial stimuli either as art, as non-art, or by presenting mixtures of similar looking art and non-art stimuli (Alvarez et al., 2015; Gerger et al., 2014; Haertel & Carbon, 2014; Hawley-Dolan & Winner, 2011; Snapper et al., 2015; Pelowski et al., 2017b; Wagner et al., 2014). In general, it was found that viewers ascribed a higher aesthetic quality and higher liking scores to works they considered art (Haertel & Carbon, 2014; Hawley-Dolan & Winner, 2011; Pelowski et al., 2017b). Increased positive aesthetic judgments as well as increased positive emotional evaluations were even found for disgusting photographs if they were framed as being works of art instead of documentary photos (Gerger et al., 2014; Wagner et al., 2014). In a series of studies by Winner and colleagues (Alvarez et al., 2015; Hawley-Dolan & Winner, 2011; Snapper et al., 2015), viewers' abilities to differentiate between abstract art and similar looking pictures by children or animals were investigated and corresponding processing differences were analyzed. It was found that viewers ascribed more structure and more intentionality to works of abstract art than non-art paintings by children and animals (Snapper et al., 2015). Furthermore, those pieces of art that were often confused with non-art were rated low in structure and intentionality, while the reverse pattern was found for those non-art paintings that were often confused with artworks (Snapper et al., 2015). Differences in processing were also manifest on a perceptual level (Alvarez et al., 2015). When people were shown pairs of art and non-art images without telling them that one was a piece of art and the other stemmed from a child's hand or an animal's paw, they looked significantly longer at the artists' works than at works created by children or animals if they had to make a judgment of a painting's quality (Which image is a better work of art?). However, no corresponding differences were found for fixation durations during preference ratings (Which image do you like more?). Also, pupil dilation was greater when fixating an artist's work, indicating higher

preference, higher mental processing effort, or both. But, unexpectedly, longer fixations on artists' images did not indicate a higher but instead a lower probability of choice.

Taken together, these findings consistently show that images are judged to be more aesthetically pleasant and to be of higher quality if declared or considered art. In addition, there is also first evidence that works of art are processed differently from non-art, as indicated by measures of gaze behavior. But regarding the notion of a specific mode of aesthetic perception triggered by a top-down art schema, empirical evidence is still inconclusive for two reasons.

Firstly, differences of gaze behavior between works of art and non-art images may not only be caused by schema driven top-down processes but by bottom-up processes as well; that is, while being superficially similar, works of art may differ from non-art images in some pictorial features which shape viewing behavior in a bottom-up manner (Hayn-Leichsenring, 2017). In line with this argument, studies that have presented mixed sets of images of art and non-art found that images of art were judged to be more structured and intentional (Snapper et al., 2015) and to be of higher originality and ambiguity (Haertel & Carbon, 2014). Such attributes may both shape gaze behavior and may also lead viewers to classify the images as being works of art in a bottom-up manner. Therefore, in order to empirically disentangle top-down from bottom-up processes in aesthetic perception, the status of images as art or not-art should be systematically crossed with their declaration as being art or non-art. In the case of bottom-up effects, differences in viewing behavior should be evoked by art versus non-art pictures, irrespective of their declaration, whereas in the case of top-down effects, differences in viewing behavior should be evoked by framing the images as art versus non-art, irrespective of their "true" art-related status.

Secondly, even if processing differences between art and non-art stimuli are caused by top-down processes, these differences do not necessarily indicate a mode of processing that is

specific to art. In previous studies on this topic, images of art were either mixed with images of everyday objects or mixed with images by the hands of children or by animals. In both cases, the non-art stimuli may have simply been processed more superficially, either because of their familiarity (in case of everyday objects) or because they were considered less significant types of art-like stimuli (in case of paintings by children or animals). But while increased processing effort may be a feature of art perception, it may be valid for other, non-art types of pictorial material as well.

Scientific images are one class of pictures that also require close inspection and increased processing effort. In addition, there is a long tradition of a reciprocal influence of works of art and images of science, with Leonardo da Vinci as an early prominent example. In modern and contemporary art, many artists make use of scientific images in their works, like Peter Paul Rubens in the 17th century or Paul Klee, Sigmar Polke, or Ólafur Eliasson in the 20th and 21st century. In addition, works of op art present visual patterns that bear a close resemblance to stimuli in psychological experiments on optical illusions. Therefore, mixed sets of similar looking works of abstract art and images from scientific publications may provide a means of analyzing characteristics of art-related viewing behavior beyond mere differences in processing effort.

Based on the above considerations, we ran two experiments investigating the influence of top-down and bottom-up processes on the aesthetic perception and aesthetic judgment of art versus non-art images by art laypersons. We first compiled a set of images consisting of similar looking works of art and scientific depictions. Then, we ran Experiment 1 in order to identify those images from our image set that art laypersons classified equally likely as being either artwork or scientific depiction. This pre-selection of images that were ambiguous with regard to their state of being either an artwork or scientific depiction allowed us to manipulate participants top-down evaluation of those images by framing them as being either

artwork or scientific depictions in Experiment 2. Thus, Experiment 2 provided a strong test of both top-down factors (framing as artwork or scientific depiction) and bottom-up factors (actual image type) on the aesthetic processing of those images by art laypersons. We measured both eye-movements and aesthetic judgments. If top-down factors influence participants' aesthetic perception and judgments, framing the images as being either artwork or scientific depictions should influence eye-movements and judgments irrespective of the images' actual state of being artwork or not. In addition, if bottom-up factors influence participants' aesthetic perception and judgments, the images' actual image type – artwork or scientific depiction – should influence participants' eye-movements and judgments.

Experiment 1: Selection of Ambiguous Artwork and Scientific Depictions

Method

Participants

We recruited 33 participants for participation in this experiment. One participant reporting high prior knowledge of the images presented in this study was removed from the data set resulting in our final sample of 32 participants (23 female, 8 male; one participant did not provide information regarding gender, $M_{\text{age}} = 23.38$ years, $SD_{\text{age}} = 5.87$; four participants did not provide information regarding their age) who were equally distributed across our two experimental groups (16 participants per experimental group). The participants were students at the University of Regensburg. Students of art history were not allowed to participate. This experiment was approved by the ethics committee of the University of Regensburg, and the participants provided informed consent prior to participation. All participants had normal or corrected-to-normal vision. The participants received chocolate for their participation if they wished.

Apparatus and Stimuli

We programmed the experiment using PsychoPy Builder (Peirce et al., 2019), presented the stimuli using a 24-inch screen (1920x1200 pixels) and collected responses using standard keyboards. We had six identical experimental setups and tested up to five participants simultaneously. Participants were placed at an unrestricted viewing distance of 60 cm to the screen.

The authors, both art historians and psychologists, discussed several possible fields of commonalities between artworks and scientific depictions, and finally decided to search for works of abstract art that resembled visual stimuli used in experiments on human perception, and vice versa. As result, each participant viewed 76 images (38 artworks, 38 scientific depictions). All images were scaled to take up the same area of 240 degree of visual angle squared on the screen while retaining the original aspect ratio, resulting in image widths between 12.00 and 27.28 degree of visual angle and image heights between 8.80 and 20.00 degree of visual angle.

Procedure

The participants were instructed that they would see a series of images and that their task was to decide for each image spontaneously how likely they thought that the image was either an artwork or a scientific depiction, according to the framing condition that they were assigned to. The stimuli were displayed in random order and participants gave their responses without any time restrictions. For each image, a rating was required by the participants. The question “Is this an artwork?” or “Is this a scientific depiction?” (according to the experimental group) was positioned under the image together with a rating scale ranging from 1 (very unlikely) to 7 (very likely). The participants gave their answer by pressing the respective number (1 to 7) on the keyboard and confirming their response with the Enter key. Once participants gave their response, the next image appeared following an inter-stimulus

interval of 500 ms. Once the participants had completed all 76 stimuli, they were requested to contact the experiment operator, who then handed out a questionnaire on which they first indicated all images that they had been familiar with prior to this experiment and then provided details on their age, gender, optical interferences, and their knowledge of art history (very good knowledge, good knowledge, basic knowledge, and no knowledge).

Design

We manipulated whether participants either rated the images regarding the likelihood of being an artwork or the likelihood of being a scientific depiction. Thus, we had a one-factorial design with two levels (framing: artwork vs. scientific depiction; between-participants).

Analysis

We analyzed our data with *R 4.0.3* (R Core Team, 2020). We used the *renv* package (Ushey, 2021) as R dependency management, allowing other researchers to easily install the packages (including their versions) that we used for our analyses.

Results and Discussion

We first ensured that our participants were equally distributed across our two framing conditions regarding the variables knowledge of art history, age, and gender. As expected, given the random assignment of participants, there was no significant difference in the distribution of knowledge of art history across the two framing groups, $X^2(3) = 3.92, p = .270$, with most participants reporting no or only basic knowledge (note: one participant did not provide information on knowledge of art history). Further, a Welch *t*-test indicated that there was also no significant difference in age between the framing conditions, $t(18.64) = -1.66, p = .113$, and there was also no significant difference in the distribution of gender across framing conditions, $X^2(1) < 0.01, p = 1.000$.

In order to identify a set of images that are equally likely perceived as either artwork or scientific depiction, we performed the following steps. First, we inspected participants' mean prior knowledge across all images using a boxplot and identified six outlier images (2 artwork, 4 scientific depiction) that were particularly known to the participants and thus removed from the data set. In a second step, we compared the likelihood ratings of the artwork framing condition and scientific depiction framing condition using a Welch t -test for each image. We then removed all images with a p -value lower than .150 from the data set (26 artwork, 20 scientific depiction). We intentionally chose this liberal alpha error level in order to only keep images in our data set that were not too close to the common .050 significance threshold. We then ordered the remaining images (10 artwork, 14 scientific depiction) according to the mean overall rating in a descending order and chose the eight images of each kind with the highest ratings. Figure 1 depicts the ratings of the final set of 16 images (8 artwork, 8 scientific depiction) that we had selected based on this experiment. For each image of this final set, a maximum of five participants (out of 32 participants) indicated having known the image prior to our experiment. Furthermore, the average overall rating for this final set of images did not differ significantly between the two image types (artwork: $M = 3.74$, $SD = 1.02$; scientific depiction: $M = 3.71$, $SD = 0.80$) as indicated by a paired t -test, $t(31) = 0.20$, $p = .846$.

Experiment 2: Gaze Behavior and Aesthetic Judgments

Method

Participants

We recruited 82 participants for participation in this experiment. Due to missing data in the eye-movements log files, we removed four participants from the data set resulting in our final sample of 78 participants (56 female, 22 male, $M_{\text{age}} = 31.62$ years, $SD_{\text{age}} = 12.94$) with 38 participants assigned to the artwork framing condition and 40 participants assigned to the

scientific depiction framing condition. The participants were students and employees at the University of Regensburg. Students of art history were not allowed to participate in this experiment. This experiment was approved by the ethics committee of the University of Regensburg and the participants provided informed consent prior to participation. All participants had normal or corrected-to-normal vision. After the experiment, the participants received chocolate for their participation and were debriefed by the experimenter about the experimental manipulations.

Apparatus and Stimuli

We used an SMI REDn Scientific eye-tracker for the recording of eye-movements. The eye-tracker was attached to the lower frame of a 24-inch screen (1920x1200 pixels) that we used for stimulus presentation. It ran in smart binocular mode and with a sampling frequency of 60 Hz. We used a two-computer laptop with a dedicated recording laptop connected to the eye-tracker and a separate desktop computer for stimulus presentation. In addition to the monitor used for stimulus presentation, there was a second monitor used by the experimenter to start and control the experiment. This screen provided the experimenter with a live gaze preview of the participant. The desk of the operator was positioned behind the participant and was used to start the experiment and to monitor the calibration.

As stimulus material, we used the 16 images (8 x artwork, 8 x scientific depiction, see Table 1 and Figure 2) that we selected based on Experiment 1. All stimuli were presented in full screen mode while retaining their original aspect ratio, thus adding black bars at the sides or top and bottom whenever needed. We manipulated the framing of what kind of images would be presented to the participants throughout the experiment. The images were framed as being either artwork or scientific depictions. This framing was applied for all texts presented throughout the experiment, that is, in the instruction when announcing the next image and when asking for the ratings at the end of the experiment.

Procedure

After seating the participants in front of the 24-inch screen, they received a short verbal instruction that their eye movements will be tracked and how the calibration works. They then gave written informed consent. Next, we presented a written instruction on the screen informing the participants that they should first look carefully at a series of images and then give a rating on a number of dimensions of these images. The term image was framed as either artwork or scientific depiction according to the experimental group. The experimenter ensured that the participants were seated at an unrestricted viewing distance of 60 to 70 cm and started a 13-point calibration. Before the presentation of each image, we performed a short 4-point validation. During both calibration and validation, participants manually confirmed their fixations on the visual targets by pressing the spacebar on the keyboard that was lying in front of them. Validation results were displayed on the screen of the experimenter who re-ran the 13-point calibration whenever a large deviation between recorded gaze locations and the validation targets occurred.

Each of the 16 free-viewing trials started with a text slide announcing the next image, framed as *artwork 1* to *artwork 16* or *scientific depiction 1* to *scientific depiction 16*, according to the experimental group. Participants started the trial by pressing the spacebar. After the validation, the participants free-viewed the presented image for 20 seconds. Then, the next trial started. The free-viewing trials were presented in a random order for each participant.

Following the free-viewing trials, the participants rated each picture on four dimensions (meaningfulness, liking, structuredness, complexity). For each rating, we presented the image reduced to 73% of its size with the respective question and a scale from 1 (not at all) to 7 (very much) beneath it: 1. How meaningful is the artwork/scientific depiction for you – that is, do you think that you can understand it and give it meaning? 2. How do you like the

artwork/scientific depiction – that is, is the viewing a pleasant experience? 3. How structured does the artwork/scientific depiction appear to you? 4. How complex does the artwork/scientific depiction appear to you? The participants gave their response by hitting the respective key (1 to 7) on their keyboard. After each question, they pressed the spacebar in order to continue to the next rating. Once they rated all dimensions for one image, they proceeded to the next image. Within this rating phase, the 16 images were presented in the same fixed order for each participant, namely, in the order in which they are also presented in Table 1.

Following these ratings, we successively presented each image again (in the same order as during the ratings), asking the participants whether they had already been familiar with the respective images. They responded by hitting either the 1 (yes) or 2 (no) on the keyboard. Unfortunately, we had phrased this question too ambiguously such that some participants responded whether they remember seeing the image during the experiment instead of knowing it from before the experiment. Thus, we will not consider the responses to this question any further. Finally, the participants were asked about their age, gender, optical interferences; their interest in art and their interest in (natural) sciences were both rated on a scale from 1 (not at all) to 7 (definitely) and their knowledge of art and their knowledge of (natural) sciences both on a scale from 1 (very low) to 7 (very high). For all ratings and questions, there were no time limits. The participants first gave their response by pressing the respective number on the keyboard and then proceeded to the next rating or question by hitting the spacebar. In the rare event that participants gave more than one response before hitting the spacebar, we used the first response for the analysis.

Some participants asked right after the introduction whether they had to remember the images for the ratings afterwards. The experimenter informed those participants that the

images would also be displayed alongside the ratings after the free-viewing task and that they would not perform a memory test.

Design

We manipulated the framing of the presented images between-participants. For one half of the participants, we framed the images as being artwork, and for the other half of the participants, we framed the images as being scientific depictions. Further, we manipulated the actual presentation of images within-participants. One half of the images were actual artwork, and the other half of images were actual scientific depictions. Thus, we had a 2 (framing: artwork vs. scientific depiction; between-participants) x 2 (image type: artwork vs. scientific depiction; within-participants) design.

Data Preparation and Analysis

For the analysis of our eye-movement data, we first removed the few trials having a trial duration deviating more than 200 ms from the expected 20 s trial duration (8 trials across all participants, 0.64% of the data). We screened the tracking ratio (percentage of valid gaze samples) across the trials in a second step. This revealed a very high tracking ratio for most trials (*Mdn* = 97.62%; *10%-quantile* = 92.73%; *90%-quantile* = 99.71%). To ensure that data stemming from trials with a poor tracking ratio did not distort our eye-movement measures, we removed all trials with a tracking ratio below 90% from our data set before the analysis (73 trials across all participants, 5.85% of the data). For the analysis of the aesthetic judgments, we used all data except for the very few instances in which participants proceeded without giving a rating response (20 ratings across all participants, 0.40% of the data).

We analyzed our data with linear mixed-effects models that included the main effects of framing (artwork vs. scientific depiction) and image type (artwork vs. scientific depiction) as well as the interaction of framing and image type as fixed effects. Further, we added a random intercept for participant to the model. For the analysis of our eye-movement data, we

added image area as additional fixed effect to the model in order to control for the effect of varying image sizes on the eye-movement measures.

We analyzed our data with *R 4.0.3* (R Core Team, 2020). For the definition of the linear mixed-effects models, we used the *lme4* package (Bates et al., 2015). Further, we evaluated the significance of the fixed effects in the models with Type II Wald chisquare tests using the *car* package (Fox & Weisberg, 2019). The violin plots in Figures 3 and 4 were constructed using the *ggpubr* package (Kassambara, 2020). Finally, we used the *renv* package (Ushey, 2021) as R dependency management, allowing other researchers to easily install the packages (including their versions) that we used for our analyses.

Results and Discussion

We first ensured that there were no significant differences in the knowledge and interest regarding art and science between our two framing conditions using Welch *t*-tests. As expected given the random assignment of participants, there were no significant differences between the two framing conditions regarding knowledge of art, $t(64.62) = -1.00, p = .319$, knowledge of science, $t(72.55) = -0.12, p = .904$, interest in art, $t(60.77) = -1.83, p = .073$, and interest in science, $t(71.63) = 0.25, p = .805$ (note: one participant did not provide information on knowledge of art, knowledge of science and interest in science, and one participant did not provide information on knowledge and interest in art and science). Further, there was no significant difference in age between framing conditions, $t(71.12) = 1.07, p = .289$, as well as no significant difference in the distribution of gender across framing conditions, $X^2(1) < 0.01, p = 1.000$.

Gaze Behavior

For the classification of raw gaze data into fixations and saccades, we used the event detection algorithm included in the SMI BeGaze 3.7.5 software package (parameters: low

speed event detection, min. duration: 80 ms, max. dispersion at 60 cm: 2°, max. dispersion at 80 cm: 3°). We analyzed the data from the right eye.

We analyzed the dependent measures number of fixations, fixation duration, scanpath length, and mean distance of fixations to screen center (see Figure 3) with linear mixed-effects models (see analysis section for details). There was a significant main effect of image type for all four dependent measures, with participants showing more, $X^2(1) = 99.83, p < .001$, and shorter, $X^2(1) = 42.26, p < .001$, fixations, a longer scanpath, $X^2(1) = 122.36, p < .001$, and a larger distance of fixations to the screen center, $X^2(1) = 4.46, p = .035$, for images that were actual scientific depictions as compared with images that were actual artwork. The framing of the images as being either artwork or scientific depictions, however, did not influence eye-movement behavior across all four dependent measures as indicated by both the non-significant main effect of framing, all $X^2s(1) \leq 1.44, ps \geq .230$, as well as the non-significant interaction of framing and image type, all $X^2s(1) \leq 3.04, ps \geq .081$. Regarding the covariate image area, increasing image area was associated with fewer, $X^2(1) = 9.47, p = .002$, and longer, $X^2(1) = 8.03, p = .005$, fixations as well as a larger distance of fixations to the screen center, $X^2(1) = 33.86, p < .001$, but it was not significantly associated with scanpath length, $X^2(1) = 0.82, p = .366$. Further, just as one would expect with a fixed viewing time, there were significant correlations between our eye-movement measures (see Appendix A). Thus, when interpreting our results, one should consider the changes in overall gaze behavior rather than considering the different measures in isolation.

In a next step, we analyzed the similarity of scanpaths using the ScanMatch method (Cristino et al., 2010). This method had already previously been applied to the study of art experience (Pihko et al., 2011) and allows for the analysis of the similarity of scanpaths within a group of participants. We used the following parameters for our ScanMatch analysis: stimulus resolution: 1920 x 1200 pixels, number of bins: 20 x 12, substitution threshold: 3.83,

gap value: 0, temporal bin size: 100 ms. For each experimental condition separately, we compared the scanpath of each participant pairwise with the scanpaths of all other participants and computed the mean of those scores as an index of the similarity of the participant's scanpath to the respective group (see Figure 3). We analyzed the ScanMatch scores with a linear mixed-effects model (see analysis section for details). This revealed a significant main effect of image type, $X^2(1) = 14.61, p < .001$, a significant main effect of image area, $X^2(1) = 177.18, p < .001$, a non-significant main effect of framing, $X^2(1) = 1.74, p = .187$, and a non-significant interaction of framing and image type, $X^2(1) = 0.01, p = .933$. Thus, the framing of the images as depicting either artwork or scientific depictions did not influence the viewing patterns of our participants in a way that might have produced more similar patterns within one of the two experimental groups. Further, viewing patterns across participants were somewhat more similar for images that took up a smaller area and for images that were actual scientific depictions rather than actual artwork. Note that the latter effect was the model prediction after controlling for image area and was opposite to the descriptive data depicted in Figure 3.

Aesthetic Judgments

For each rating scale separately (see Figure 4; correlations see Appendix B), we fit linear mixed-effects models containing framing (artwork vs. scientific depiction), image type (artwork vs. scientific depiction), and their interaction as fixed effects, and a random intercept for participant as random effect.

Regarding the rating scale meaningfulness, there was a significant main effect of image type, $X^2(1) = 4.93, p = .026$; that is, the scientific depictions were rated as more meaningful than the artwork. Both the main effect of framing, $X^2(1) = 0.51, p = .474$, as well as the interaction of framing and image type, $X^2(1) = 0.75, p = .388$, were not significant.

Regarding the rating scale liking, there was a significant main effect of framing, $X^2(1) = 4.62, p = .032$, a non-significant main effects of image type, $X^2(1) < 0.01, p = .990$, and a non-significant interaction of framing and image type, $X^2(1) < 0.01, p = .999$; that is, the participants being told that they were looking at scientific depictions rated the images with a higher liking value than the participants being told that they were looking at artwork irrespective the actual source of the images.

Regarding the rating scale structuredness, both the main effects of image type, $X^2(1) = 2.47, p = .116$, and framing, $X^2(1) = 0.43, p = .514$, as well as the interaction of framing and image type, $X^2(1) = 0.02, p = .881$, were not significant.

Regarding the rating scale complexity, there was a significant main effect of image type, $X^2(1) = 33.46, p < .001$; that is, the artwork was rated as being more complex than the scientific depictions. Both the main effect of framing, $X^2(1) = 0.02, p = .886$, as well as the interaction of framing and image type, $X^2(1) = 0.13, p = .719$, were not significant.

General Discussion

Ambiguous works of modern art not only often provoke laypersons to pose the question “Is it art?”, but may also be processed differently by viewers, depending on whether the question is answered affirmatively or not. More specifically, present models of art perception posit that judging a given picture or object as an artwork evokes a respective cognitive schema which operates in a top-down manner by guiding gaze behavior, increasing depth of processing and influencing evaluation in terms of liking and understanding. In light of this, the present study investigated the impact of this fundamental dichotomy between art and non-art on viewers’ gaze behavior and aesthetic judgments. In addition, by systematically crossing the actual status of images as art or non-art with their declaration as being art or non-art, we aimed to distinguish possible bottom-up from top-down processes. In particular, in the case of bottom-up effects, differences in viewing behavior should be evoked by actual art versus

non-art pictures, irrespective of their declaration, whereas in the case of top-down effects, differences in viewing behavior should be evoked by framing the images as art versus non-art, irrespective of their actual art-related status.

Care was taken to select a set of both actual art and non-art pictures that could be interpreted as being art and non-art to a similar degree. To this end, Experiment 1 compared pieces of abstract art with similar looking scientific images from studies of perception, identifying pictorial stimuli that art laypersons classified equally likely as being either artwork or scientific depiction. Interestingly, no pictorial stimuli were found that were rated to be very likely artworks and at the same time to be very likely scientific depictions. Instead, all pictorial stimuli (both true artworks and true scientific depictions) that met the criterion of being ambiguous in this respect lay in the middle range of how likely they were judged to be artwork and scientific depiction.

Although the average overall ratings did not differ for the resulting sets of eight artworks and eight scientific depictions, the actual image type did substantially influence both gaze behavior and ratings of the lay viewers in Experiment 2. In particular, compared to scientific depictions, looking at actual artworks led to fewer and longer fixations, a shorter scanpath, and a shorter distance of fixations to the screen center. Also, viewing patterns across participants were more similar for the images that were actual scientific depictions than the images that were actual artwork. In addition, actual artworks were rated as being more complex but less meaningful than actual scientific depictions, whereas no differences were found regarding perceived structuredness and liking. In contrast, declaring pictures as being either artworks or scientific depictions, irrespective of their actual status, did not have any substantial influence on gaze behavior and perceived complexity, structuredness, or meaningfulness, but did influence liking. Surprisingly, pictures declared to be artworks were rated lower in liking than pictures declared to be scientific depictions.

Taken together, the pattern of results reveals some insights into the processing consequences of the dichotomy between art and non-art. First, although the pictures had received highly similar ratings on the likelihood of being artworks and scientific depictions in Experiment 1, they were differentially looked at and rated in Experiment 2, depending on their actual status. This is in line with previous studies that have shown that lay viewers succeed at an above chance rate in identifying artworks in carefully matched pairs of actual abstract expressionist paintings and similar looking paintings by a child or an animal (Snapper et al., 2015). It indicates that while being similar in general visual appearance, works of art may differ from non-art images in some subtle pictorial characteristics which shape viewing behavior in a bottom-up manner (Hayn-Leichsenring, 2017). While Snapper et al. (2015) identified perceived structure as a relevant dimension that allowed viewers to distinguish art from similar-looking non-art, the present study did not find perceived structure but rather perceived complexity to differ between actual works of art and scientific depictions, the former receiving higher ratings than the latter.

Differences between actual works of art and scientific depictions were found for several dimensions that have been used to describe art-related patterns of looking. In particular, it has been argued that looking at art is characterized by close inspection and deep processing, as indicated by longer fixation times, by holistic scanning of the whole picture instead of exclusively focusing on particular pictorial elements, as indicated either by a higher ratio between short fixations covering a large area of the artwork and long fixation covering small areas or by a higher ratio between long global and short local scanpaths, and also by homogenizing gaze patterns across different viewers due to aesthetic principles of composition that shape viewers' gaze (Nodine et al., 1993; Zangenmeister et al., 1995). The present study partly confirms these assumptions. In particular, mean fixation times were longer for actual pieces of art than for non-art, which corresponds to previous findings

(Alvarez et al., 2015). As mean fixation time is considered a proxy for depth of processing, the present result indicates that actual artworks were elaborated more deeply than scientific depictions. On the other hand, in contrast with the notion that compositional attributes of artworks guide the viewers' gaze behavior, a greater similarity between individual scanpaths was found for scientific depictions than for works of art. Also, no evidence was found that works of art are processed more holistically. Previous studies did find longer scanpaths and higher ratios of global versus local saccades for abstract artworks in comparison to figurative artworks, particularly for viewers with high expertise in art (Pihko et al., 2011; Vogt & Magnussen, 2007; Zangemeister et al., 1995). In contrast, the present study found that lay viewers' gaze while looking at works of art showed a more pronounced center bias and shorter scanpaths than while looking at actual scientific depictions, indicating that both types of pictorial material and expertise in art have to be taken into account when interpreting gaze patterns as global or local.

Interestingly, differences in gaze behavior were observed only for actual works of art but not for works declared to be art. This finding speaks against the notion of an art-specific cognitive schema that guides top-down visual processing of works of art. Instead, the observed differences in mean fixation times seem to result from a bottom-up processing of subtle characteristics of the works' visual appearances. Which kind of characteristics might contribute to these differences is an open question that needs to be investigated in future studies. Possible candidates range from different color scales to spatial distribution of image elements to drawing precision of lines and geometric shapes. AI-assisted clustering of large mixed sets of abstract paintings and similar looking scientific depictions could be a promising methodological approach to address this question.

The declaration of depictions of artworks versus scientific images also did not have any substantial effects on various parameters of gaze behavior nor on ratings of structuredness,

complexity, or meaningfulness, again speaking against the operation of an art-specific schema that guides art perception in a top-down manner. Only liking, the most proximate indicator of aesthetic judgment, was shown to be significantly influenced by a systematic variation of declaration. Hence, while visual processing of the pictorial stimuli was influenced by their actual status, aesthetic judgment was influenced by the respective declaration, suggesting that both aspects of art perception were not directly linked.

Unexpectedly, liking was higher when the presented images were declared to be scientific rather than artistic works. In contrast, several studies found that viewers gave higher liking scores to works they considered to be art than non-art, both for sculptural objects, paintings, and photographs (Gerger et al., 2014; Haertel & Carbon, 2014; Hawley-Dolan & Winner, 2011; Pelowski et al., 2017b; Wagner et al., 2014). As a main difference, former studies contrasted works of art either with pictures of everyday objects or works considered to be aesthetically inferior (paintings by children), while the present study contrasted them with scientific depictions. Previous studies have reported that lay viewers tend to prefer figurative artworks over pieces of abstract art, attributing higher artistry to the production of the former (Pelowski et al., 2016; Pelowski et al., 2017b; Sidhu et al., 2018). We speculate that similar mechanisms of preference may also hold for scientific depictions in comparison to abstract art, with the former seen as being of higher “craftsmanship”. In addition, higher liking of scientific depictions may also have been influenced by the sample of participants, who were mainly university students or employees, an issue which should be addressed in future studies.

Finally, participants rated actual artworks to be less meaningful than actual scientific depictions, irrespective of their declaration as artworks or scientific images. This is surprising because non-figurative depictions do not instantly convey a certain meaning but often require additional contextual information, for example, titles or explanations (Belke et al., 2006;

Leder et al., 2006; Swami, 2013). Accordingly, declarations as artworks or scientific images should have exerted an influence of perceived meaningfulness, which was not the case in the present study. While some subtle differences in visual appearance between both types of pictures seem to be responsible for this finding, further research on meaning making processes with abstract art is necessary. In particular, methods such as thinking aloud protocols will allow perceived meaningfulness in terms of a single numeric dimension to be complemented by qualitative in-depth analyses of the meaning-making processes involved.

There are also certain limitations of the present study that have to be taken into account. In particular, the pictorial stimuli were shown full-size on a 24-inch screen. Hence, actual size differences between the depictions were mostly leveled. Because the size of most of the actual artworks was larger than screen size, while the size of the scientific depictions was substantially smaller than screen size, this divergence may have influenced both gaze patterns and ratings. Also, the pictorial stimuli used in the present study do not represent the whole range of abstract art or scientific depictions but were chosen to be as similar as possible. Therefore, future studies should investigate to what extent the present findings can be generalized to different sets of pictorial stimuli.

Still, with these limitations in mind, the pattern of results indicates that while the dichotomy between art and non-art indeed strongly influences the lay viewers' gaze behavior and aesthetic judgments, this influence was primarily caused in a bottom-up manner by subtle differences in visual appearance instead of top-down effects triggered by a specific cognitive art schema.

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Figure 1

Final set of images (8 artwork, 8 scientific depiction) selected based on Experiment 1

Note. Mean ratings of participants on the likelihood of images being either an artwork (art) or scientific depiction (sci), respective the assigned framing condition. Error bars indicate the standard error of the mean.

Figure 2

Images (8 artworks, 8 scientific depictions) used as stimulus material in Experiment 2

Note. The images are numbered according to Table 1. For copyright reasons, the images are reproduced in grayscale, but they were presented in color in the Experiment.

Figure 3*Violin Plots of the Eye-Movement Measures in Experiment 2*

Note. The violin plots show the distribution of the eye-movement measures across participants. The dot and error bars within the violin plots indicate the mean and standard error of the mean, respectively.

Figure 4*Violin Plots of the Aesthetic Judgments in Experiment 2*

Note. The violin plots show the distribution of the image ratings across participants. The dot and error bars within the violin plots indicate the mean and standard error of the mean, respectively.

Table 1

Source for each of the 16 images (8 artwork, 8 scientific depiction) that were selected based on Experiment 1 and used as stimulus material in Experiment 2

Artwork
1 Josef Albers, Strukturele Konstellation, 1954, The Josef and Anni Albers Foundation
2 Josef Albers, Unmögliches, 1931, Solomon R. Guggenheim Museum, New York
3 Richard Anuszkiewicz, Brightness as a third Dimension, 1960, University of California, San Diego
4 Carlos Cruz-Diez, Induction Chromatique 39, 1971, Museum of Fine Arts, Houston
5 Edwin Mieczkowski, Monobloc No. 1, 1966, Louisiana Museum of Modern Art
6 Gerhard Richter, Strip, 2011, Museum Frieder Burda, Baden-Baden
7 Jean-Pierre Yvaral, Polychromatic Diffraction (Diffraction Polychrome), 1970, Collection Albright-Knox Art Gallery, Buffalo, New York
8 François Morellet, 4 trames 22°5, 45°, 67°5, 90°, 1969, exhibited at Sperone Westwater, Summer 2012
Scientific Depiction
9 Demonstration of the vividness of peripheral color vision (Figure 3 in Tyler, 2015)
10 Hering illusion (Hering, 1861) downloaded from https://commons.wikimedia.org/wiki/File:After_parallel.PNG
11 Colored version of the Café Wall Illusion (Gregory & Heard, 1979) downloaded from https://de.wikipedia.org/wiki/Datei:Caf%C3%A9_Wall_Illusion_2.jpg
12 White's illusion (Figure 1 in Betz et al., 2015)
13 Depiction of stimulus material (Figure 2 in Webster et al., 2002)
14 Two frames of the contrast asynchrony display (Figure 2 in Shapiro, 2008)
15 Intertwining illusion (Figure 8 top in Pinna & Gregory, 2002) downloaded from https://upload.wikimedia.org/wikipedia/commons/4/45/Pinna%27s_illusory_intertwining_effect.gif
16 Depiction of stimulus material (Figure 2 in Scaccia & Langer, 2018; Note: labels were removed)

Appendix A*Correlation table of eye-movement measures collected in Experiment 2*

Variable	1	2	3	4	5
1. Number of Fixations	—				
2. Fixation Duration	-.89 ^{***}	—			
3. Scanpath Length	.77 ^{***}	-.70 ^{***}	—		
4. Distance of Fixations to Screen Center	.36 ^{**}	-.41 ^{***}	.58 ^{***}	—	
5. Mean ScanMatch Score	-.03	-.01	-.20	-.63 ^{***}	—

Note. Correlations were calculated at the participant level.

** p < .01. *** p < .001

Appendix B*Correlation table of aesthetic judgment scales collected in Experiment 2*

Variable	1	2	3	4
1. Meaningfulness	—			
2. Liking	.31**	—		
3. Structuredness	.25*	.27*	—	
4. Complexity	.11	.25*	.32**	—

Note. Correlations were calculated at the participant level.* $p < .05$. ** $p < .01$