Tracking Frank Stella: an Empirical Evaluation of Art-Historical Issues in an Eye-Movement and Questionnaire Study

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Abstract

An eye-tracking and questionnaire study was set up in collaboration with the Van Abbemuseum (Eindhoven, The Netherlands) to investigate the perception and appreciation of three Frank Stella paintings from the 60s (*Tuxedo Park Junction* and *Effingham I* from the collection of the museum and a hand-painted replica of *Hiraqla Variation II*). *Effingham* and *Hiraqla* were shown next to a printed copy without fluorescent colors, for a direct comparison between the two versions. The main purpose of the study was to assess whether the works were experienced according to Stella's prescriptions as defined in his Modernist 'logic': all-overness, flatness, instantaneousness and self-referentiality. We found that the perception of *Tuxedo* resulted in a well-structured, coherent heatmap, while a more or less even distribution of fixations over the surface was found in the case of *Effingham* and *Hiraqla* (and their copies), which indicates that Stella's target of all-overness was achieved better in the last two works. Although Stella claimed to have created "flat and frontal" paintings, depth was experienced, especially in *Tuxedo* and the *Hiraqla* replica. In the latter, this was mainly caused by the protruding fluorescent colors. Also, in this work more fixations were found in fluorescent-colored areas when corrected for area size. No such effect was found in the original *Effingham* painting. Most participants found only *Effingham* to be instantaneously capturable.

In the case of *Tuxedo*, the specific material qualities, like alkyd and open canvas, were rarely recognized, which undermines Stella's aim for self-referentiality. Participants noticed the fluorescent effect in the *Hiraqla* replica, but they did not mention other material qualities. A reverse effect was found for *Effingham*.

Keywords

Eye tracking, questionnaires, perception of paintings, Frank Stella, modernist logic, color, depth, pattern

1. Introduction

1.1. General Introduction

The present study aims to investigate the viewing experience of three works by Frank Stella (born 1936) [*Tuxedo Park Junction* (1960), *Effingham I* (1967) and *Hiraqla Variation II* (1968)]. Stella created them according to a strict logic which can be considered both an adaptation and an improvement of Clement Greenberg's (1909–1994) Modernist logic. Greenberg was the first to launch the idea that an artist should stay true to the specific physical characteristics of an art medium ('medium specificity'): "The purely plastic or abstract qualities of the work of art are the only ones that count. Emphasize the medium and its difficulties, and at once the purely plastic, the proper, values of visual art come to the fore" (Greenberg, 1940/1986, p. 34). In the case of painting, he stresses the notion of 'flatness,' by which paint on canvas should be perceived as the main subject on a pictorial surface (Greenberg, 1960/1995). Stella departs from Greenberg's notion of flatness, but goes further by considering which elements are strictly necessary to generate the essence of painting (De Duve, 1996; De Winter, 2020; Rubin, 1970).

Each series that Stella made during the sixties and seventies, can be considered as an investigation into obtaining 'anti-illusionistic painting': "My paintings are based on the fact

that only what can be seen there is there. [...] What you see is what you see" (Glaser, 1964/1995, p. 158). The search for anti-illusionistic painting led him to an instantiation of a set of concrete principles, which can be summarized as follows: in order to provide pure abstraction, a painting should be instantly experienced in its 'objectness,' free from connotations with its tradition (De Winter, 2020; Rubin, 1970). According to the artist, this can be obtained through the use of an all-over design, house painter techniques and materials, self-referential paints and shaped canvases (De Winter 2020; Rubin, 1970).

These principles either refer to perceptual properties of the works (e.g., transparency, depth effects, and fast capturability) or to judgments that are partly based on these properties (e.g., all-overness, instantaneousness, self-referentiality, or anti-illusionism). By claiming that his works conform to these principles, Stella is in effect saying that they necessarily have to be viewed in accordance with them. And thus, he is assuming that viewers will see the works as he intended. Implicit in this assumption is the idea that factors like personal preference, bias, and connoisseurship will not interfere with the viewing experience he intended to generate (De Winter, 2020).

The reception of his works seems to oppose this idea. With the exception of Michael Fried (1966/1998), who praised Stella's work for being flat and frontal, critics seemed to experience and interpret the works in different ways: For example, for Donald Judd (1965), Stella's works are illusionistic, because, according to him, all paintings are inextricably linked to the illusion of spatiality. Barbara Rose (1967) and Rosalind Krauss (1990) categorized them as *abstract* illusionistic, because they wanted to distinguish Stella's work from traditional spatiality by emphasizing a new form of spatiality that is material-bound and therefore purely abstract. Consequently, it will not come as a surprise that the overall evaluation of these works varied considerably with regard to their adherence to Stella's Modernist logic. Since these evaluations rely so heavily on the aforementioned perceptual claims and judgments, they

cannot be assessed adequately without first having ascertained the validity of both the claims and judgments. Assessing their validity means determining empirically whether they can be inter-subjectively verified. This means subjecting them to a (semi-controlled) study in a wide sample of viewers.

This was already done for color depth and fast capturability in two previous laboratory studies (De Winter *et al.*, 2018, 2020). The first one (De Winter *et al.*, 2018), based on four *Irregular Polygon* paintings (1966–'67), showed that participants experienced more depth in the fluorescent colors (i.e., perceived them as protruding) than their conventional variants (as the colors appear in reproductions) or the adjacent conventional colors in the same design. This finding is inconsistent with Stella's claim (which he first made in the interview with Lane Slate) that his works are experienced as flat and frontal (i.e., have no depth effects) (Slate, 1966). In the second study (De Winter *et al.*, 2020), it appeared that participants were able to grasp stimuli that were based on Stella's *Moroccan* paintings (1964) in very short exposure times. This seems to confirm Stella's assumptions, as mentioned in the interview with Bruce Glaser, about the capability of these paintings' to instantly present themselves to the viewer (Glaser, 1964/1995). However, differences in performance were found between color combinations and color type, for instance, for the red/yellow fluorescent designs fewer errors were found than for the conventional variants, while the reverse effect was found for green/orange designs. The latter finding undermines the idea that all works of the *Moroccan* series are experienced similarly, as Stella intended (Rubin, 1970). Also, it appears that the self-referential quality of the paint cannot be experienced during short exposure times, which further undermines Stella's original intention.

With the present study, we wanted to further investigate the effect of fluorescent colors and the implications for Stella's Modernist logic, more specifically the concepts of *all-overness*, *flatness*, and *instantaneousness* (see Subsection 1.3. *Research Objectives*), in a

museum setting with real works of art, instead of isolating colors in more controlled stimuli, as was done in the previous studies. We opted for a combination of mobile eye tracking, along with questionnaires and interviews. The study took place at the Van Abbemuseum in Eindhoven, The Netherlands from 9 February to 7 April, 2019. Although the use of eye-tracking methods to study the perception of visual art is not new, using them to help assessing art-historical questions is still in its infancy. Thus far, only a few studies have used mobile eye tracking for the investigation of the perception and appreciation of real paintings (Rosenberg & Klein, 2015; Stevanov *et al.*, 2018). Rosenberg and Klein, along with James Elkins and Erna Fiorentini (2020) have pointed to the potential of eye-tracking methods for art-historical studies.

The exhibition (see Fig. 1 and Fig. 4 below, for a map of the exhibition), which was specifically set up for the study, consisted of one work from the Black Paintings, namely *Tuxedo Park Junction* (1960), one work from the *Irregular Polygons* series, namely *Effingham I* (1967) (see Fig. 5 below, top-right, original painting), and one from the *Protractor* series, *Hiraqla Variation II* (1968). First of all, these three works are chosen because they exemplify Stella's Modernist logic. In addition, the Van Abbemuseum has two Stella paintings in their collection which were suitable for the study (*Tuxedo Park Junction* and *Effingham I*). *Tuxedo Park Junction* is one of Stella's *Black Paintings* that characterize the early stage in the development of his Modernist logic. *Effingham I* is one of Stella's *Irregular Polygons*, a series created during the height of Stella's anti-illusionistic approach. The work consists of both fluorescent and conventional colors. Also, the colors of *Effingham I* were already used in an earlier study on color depth (De Winter *et al.*, 2018), which allowed for a comparison between the color (depth) effect of the more controlled study and the real art work. *Hiraqla Variation II* is a work from Stella's latest series containing fluorescent paints, the *Protractor series*. In these monumental works, Stella combined various fluorescent and conventional hues, where

some of the fluorescent colors were mixed with conventional paints. The decision to replicate *Hiraqla Variation II* was based on the fact that both the NSU Art Museum in Fort Lauderdale, Florida, where the work was on display, and Stella himself (the work is from his collection) granted permission to perform a close investigation of the work (e.g., measuring colors and detecting fluorescent pants with UV), which was performed during the summer of 2018 (see Note 1).

While Greenberg and Stella both championed the importance of material specificity in painting, the specific visual effects of paint layers, such as those of DayGlo paints in Stella's work, are rarely discussed and often overlooked in the literature. We wondered whether this problem might be linked to the fact that the fluorescent effect is lost in digital or printed reproductions, which are commonly used by authors when they write about these works. Therefore, to get a better idea of the influence of the fluorescent colors in these works, we have chosen to show the two fluorescent works next to a printed copy without fluorescent colors (Fig. 4 below). We chose to use an equal-sized print because we wanted to be able to measure the difference between a fluorescent and non-fluorescent version of the same work. Specifically, a full-sized printed copy of *Effingham I*, without fluorescent colors, was shown next to the original painting (see Fig. 5 below, top-left, printed copy). The first author made a hand-painted replica of *Hiraqla Variation II* with fluorescent colors for the occasion (see Fig. 7 below, top-right, painted replica). Her training as a painter and conservator of paintings (particularly the work of Frank Stella) enabled her to make the replica thanks to her strong knowledge of both the composition of paint layers, the techniques and the materials used. In addition, the exhibition also included a non-fluorescent print of the work (Fig. 4) (same size as the replica) (see Fig. 7 below, top-left, printed copy). The Black Painting *Tuxedo Park Junction* (1960) (see Fig. 9 below, on the left) was also investigated, but without an additional printed copy. Although this study is mainly focused on Stella's paintings with fluorescent colors, we

also wanted to compare the viewing patterns and questionnaires of the more colorful works with one of Stella's Black Paintings. We tested around one hundred participants, divided into three expertise groups: artists, art historians and laypeople.

1.2. Art-Historical Background

In the 1960s Frank Stella made paintings that evolved from simple striped patterns (*Tuxedo Park Junction*) to irregular shaped structures (*Effingham I*) and more complex circular patterns (*Hiraqla Variation II*). Our selection also reflects this evolution. He used a variation of industrial paints (black alkyd, aluminum and fluorescent paints) that were new and unconventional in art at the time. To make his painting conform to the standards of Modernism, Stella made his works according to a set of strict regulations, for instance, the use of housepainter tools and methods to eliminate the hand of the artist, leaving the canvas visible in-between the painted stripes, using patterns that refer to the stretcher of the painting (Rubin, 1970). For Stella, a Modernist painting had to be "anti-illusionistic" and it should be art that exists on its own (Rubin, 1970). With this concept, he went a step further than Clement Greenberg, who wanted to promote a painting's 'flatness' by emphasizing its medium-specific qualities (i.e., showing the brushstrokes, paint qualities and colors on the canvas, while doing away with any form of representation) (Greenberg, 1960/1995). According to Stella, a Modernist work should present itself completely (all-over), unambiguously and in an instant (Rubin, 1970). After his first successful Black Series, he mentioned this in an interview: "I wanted people to be able to see the paintings directly and unequivocally. The emphasis on the surface, on the symmetrical quality of things, was to keep people from moving around in the painting. It's non-atmospheric, non-resilient, there's no room to run around in so there's almost only one way you can see the painting. The real point of the paintings is that they're supposed

to be self-evident and supposed to be easy to see and easy to understand" (Solomon, 1970, 3). To avoid depth experiences ('true flatness'), the viewer should not engage with the pictorial surface of the work. Stella claimed to have succeeded in making 'non-relational' works that instantly present themselves as 'painting-objects.' He communicates about this idea for the first time in the famous interview with Bruce Glaser in 1964: "It really is an object. Any painting is an object and anyone who gets involved enough in this finally has to face up to the objectness of whatever it is that he's doing" (Glaser, 1964/1995, p. 158). For him, the choice for mural-sized (later also shaped) canvases, industrial paints and simple (striped) patterns or shaped configurations, cause the pictorial surface to be nothing more than a part of the whole (painting-)object (Rubin, 1970).

As indicated in the beginning of this section, one of the most striking innovations in Stella's work is his choice for non-artist, industrial paints. Stella started to use these paints because of their 'self-referential' quality, which adds to the substantiation of an anti-illusionistic aesthetic experience (Rubin, 1970). Because these paints are not traditionally used in art, they are free from connotations which tie them to other works from the art-historical canon, and thereby they only refer to themselves. This helps to minimize the engagement with the pictorial surface, which also adds to the anti-illusionistic effect he aims for (Rubin, 1970).

Tuxedo Park Junction was created in 1960 and can be regarded as one of Stella's second series of *Black Paintings*. After applying more symmetrical vertical and horizontal oriented patterns, Stella chose in this second series for diamond-shaped patterns, of which this work is an example, showing two stacked diamond patterns. This painting is made with thick stripes of black alkyd paint applied on a thin primed canvas, which leaves the structure of the cotton canvas visible.

Effingham I is part of the *Effingham* subseries, which is part of the *Irregular Polygon* series that Stella created between 1965 and 1967. The *Effingham* subseries consists of four

works that all have a primary shape, to which a secondary shape is added through the help of a band. In the case of *Effingham I*, a large irregular plane is attached to a diamond fluorescent yellow (Saturn Yellow) plane through a fluorescent blue (Horizon blue) band. The painting is made with emulsion paint (acrylic), in which the artist mixed pigment powder. He brushed the paint with a large housepainter brush on an unprimed cotton canvas.

Hiraqla Variation II is the rainbow-motive version of a subseries of three *Hiraqla Variation* paintings that Stella created in 1968. The painting contains 92 colored sections comprised of 54 unique colors, with 38 half circles consisting of two sections of the same color. Eight different colored frames are applied around the quarter circles and another eight different hues fill the small leftover spaces in the corners of the square frames. Stella used only five different pure fluorescent colors (Aurora Pink, Blaze Orange, Signal Green, Rocket Red, and Arc Yellow), and clustered three of them together in the right half circle of the painting (see Fig. 2a). The fluorescent pink is used in the smallest semicircle of the left part and the orange is applied in the largest arc on the bottom semicircular part of the painting (see Fig. 2a). Stella mixed fluorescent colors with white and other conventional hues to obtain a new variation of semi-synthetic tonalities (see Fig. 2b and c). The painting is, like *Effingham I*, made with acrylic paint, which he rolled on the unprimed canvas.

1.3. Research Objectives

The main aim of this study was to investigate whether Stella's claims concerning the anti-illusionism of his works could be corroborated for three specific works. In particular we focused on the qualities of *all-overness*, *flatness*, *self-referentiality* and *instantaneousness*.

Since fluorescent colors and the material qualities of the works play a central role in instantiating these qualities, we made printed copies (in which the fluorescent colors are

replaced with their conventional variants) of *Effingham I* and *Hiraqla Variation II*. Because of its monochrome black nature, this was not done for *Tuxedo Park Junction*.

1.3.1. All-Overness

Since his *Black Paintings*, Stella made sure that his paintings were completely covered from edge to edge with a simple geometric pattern filled in with (an) arbitrary color(s). According to the artist, his paintings should therefore generate an all-over experience (Rubin, 1970). In the case of such an all-over experience, the participants will not focus on a particular point/area in the work, but rather freely wander around the work. In his later work (since the *Irregular Polygons*, e.g., *Effingham I*, but also the *Protractor* series, e.g., *Hiraqla Variation II*) Stella creates shaped paintings that perpetuate the composition with shapes (no more striped patterns) which he filled with arbitrary colored surfaces. Such paintings should guide the viewer's attention toward the edge of and around the work, once more to prevent him/her from focusing on a single area. To validate Stella's claim of all-overness, the fixation points of the participants should be distributed more or less equally over the entire work. In the case there are single fixation areas that clearly attract more attention, this would be problematic for Stella's claim.

1.3.2. Flatness

Stella aimed to eliminate the illusion of spatiality from his paintings, which caused him to created flat and frontal works (Rubin, 1970). We were particularly interested in depth experiences created by color and in particular fluorescent colors. In De Winter *et al.* (2018), we found strong (protruding) depth effects in a more controlled study using stimuli containing color combinations taken from Stella's Irregular Polygons works. We are curious to see whether these effects will also be found when viewing real works in a museum setting. For this, we relied on questionnaires and interviews which assessed the experience of depth through

color. In addition, we asked whether participants also experienced depth through pattern and which of the two was dominant.

1.3.3. Self-Referentiality

To give his work a self-referential character, Stella insists that the materials used should be recognized as such. For example, fluorescent paints should be recognized as fluorescent paints, without referring to anything outside themselves. When analyzing the participant interviews, we therefore investigated whether participants spontaneously noticed the presence of fluorescent colors in both the original painting of *Effingham I* and the replica of *Hiraqla Variation II*. The same was done for the black alkyd paint in *Tuxedo Park Junction*.

1.3.4. Instantaneousness

As mentioned in the introduction, Stella finds that his works can be grasped instantaneously. Unlike in De Winter *et al.* (2020), it was not possible to test this using a short-exposure recognition task in the present exhibition study. Instead, we asked participants whether they experienced the works instantaneously.

1.3.5. Original Painting vs Printed Copy

We opted to include a printed copy next to the original painting of *Effingham I* (Note 2) and the replica of *Hiraqla Variation II* to investigate whether, and in what way, participants viewed and experienced the original paintings differently than their reproductions. Participants were not informed about the fact that there was a copy (mounted on a stretcher and printed on canvas) hanging next to the actual painting. This way we were able to study to what extent they noticed differences and whether the materiality of the painting, especially the fluorescent colors, more spontaneously attracted their attention than that of the copy. Besides that, we wanted to

investigate in what way Stella's central reliance on specific material qualities to inscribe his works in the Modernist logic is (spontaneously) notified and whether this was more pronounced in the paintings that contain fluorescent colors than in the fluorescentless printed copies. Secondly, we were curious to see whether the poor representation of the specific visual effects linked to fluorescent paints in the literature had to do with the fact that authors often only observe reproductions of the works. To study the differences between the experience of the printed copy and the painting, we compared the heatmaps with respect to the viewing distribution and fixation count, and through questionnaires and interviews we focused on differences in materiality, color, expertise and preference.

1.3.6. Expertise

As mentioned before (Subsection 1.2), according to Stella, each viewer should experience his work in the same way. In concrete terms, this means that differences of expertise should not affect the required viewing experience of his work. Therefore, we were curious to find out whether differences in expertise led to differences in viewing behavior, experience and preference. We therefore divided the participants into three groups, based on their expertise: artists, art historians and laypeople, in order to compare fixation counts and fixations in specific areas of interests, questionnaires, and interviews.

1.4. Hypotheses

1.4.1. All-Overness

We expected the fixations for *Tuxedo Park Junction* to show that participants mainly followed the pattern of the painting's composition. In the case of *Effingham I*, we expected to see most fixations distributed on the edge of the shaped painting and the lines of the figures in the composition. Besides that, we hypothesized that there would be more fixations on the

fluorescent yellow and blue surfaces than on the conventional orange paint surface (after normalizing for area). In the case of *Hiraqla Variation II*, we expected to find the most fixations on the fluorescent-colored areas compared to the areas with non-fluorescent paints. If so, this would mean that an all-over experience could be achieved in *Effingham I* and *Hiraqla Variation II*, as demonstrated by the wider distribution of fixations over the paintings. Finally, we hypothesized that a significant difference would be found between the fixations on the paintings containing fluorescent hues and the non-fluorescent printed copies.

1.4.2. Flatness

In the case of *Tuxedo Park Junction*, we expected that most participants would experience some depth effects inwards or outwards from the center of the concentric squares. For *Effingham I*, given the previously mentioned results of De Winter *et al.* (2018), we expected that depth would be experienced mainly through the effect of the fluorescent surfaces and less through the shapes. This would mean that more depth would be experienced in the original painting than in the printed copy. Similar results were expected for *Hiraqla Variation II*, mainly strong protruding or receding depth experiences in the painting (replica), caused by the fluorescent hues, compared to the printed copy. For the pattern of *Hiraqla Variation II*, we hypothesized that participants might see the square-shaped frames in front of the circles. If the questionnaires reveal depth experiences caused by color, and if more fixations are found on the fluorescent colors, then this might indicate that the experience of depth is primarily generated by the presence of fluorescent colors in the work.

1.4.3. Self-Referentiality

We expected that participants would notice the fluorescent hues in both *Effingham I* and *Hiraqla Variation II*. However, we thought it less likely that participants would mention the

presence of alkyd paint in *Tuxedo Park Junction*, but if this was the case, we mainly expected such responses in the group of experts.

1.4.4. Instantaneousness

We expected that participants would experience both *Tuxedo Park Junction* and *Effingham I* as instantaneous paintings. For *Tuxedo Park Junction,* this would be the case because of the black monochromatic paint surface, while for *Effingham I,* this would be the result of the large colored surfaces and shaped canvas. For *Hiraqla Variation II,* we expected that participants would find this painting visually too complex to be experienced as instantaneous, due to the combination of the many different colors and the circular patterns.

1.4.5. Original Painting vs Printed Copy

Firstly, we expected more fixations on the paintings than on the printed copies, and more on the fluorescent colors than on their conventional variants. Secondly, in the interviews, we expected a difference between experts and laymen when distinguishing between the painting (original *Effingham*, *Hiraqla* replica) and the printed copy. We assumed that the expert group was better at recognizing material properties associated with a real painting. More specifically, we assumed that mostly artists would notice a difference between the two versions and that they would spontaneously identify the printed copy as such. We only expected some experts (artists or art historians) to notice that the *Hiraqla Variation II* painting was a painted replica. Finally, we expected that participants would prefer the paintings to the printed copies.

1.4.6. Expertise

We expected that both expert groups would look at the works differently and have different preferences than laypeople (as mentioned above). We expected that experts would mostly

watch the paintings and spend less time looking at the printed copy. Moreover, as mentioned above, we expected that experts would notice more differences in materiality between the paintings and the printed copies. Furthermore, we hypothesized that the type of expertise would be reflected in the responses to the interview: art theorists would likely use their theoretical knowledge, while the artists (especially painters) would experience more material differences and distinguish the copy from the painting more easily.

2. Method

2.1. Participants

In total, we tested 103 participants, who were recruited via the museum's website, social media, the researchers' personal networks and asking museum visitors to participate on site. All participants completed the questionnaires and we collected mobile eye-tracking data from 98 of them. The data from the remaining five participants were invalid due to malfunction of the eye-tracking equipment. We made three categories of expertise groups based on education and occupation: 36 laypeople (who have no art-related background), 24 art historians (people with art-theoretical knowledge who had taken at least one course on art history and who had no experience in art practice), and 43 artists (professional artists and recreational artists who have at least some experience with art practice, have had higher art education, and/or have active knowledge on color theory).

None of the participants were younger than 18 or older than 75 years old (M = 43.86, SD = 16.95). There was no preset number of participants, although we aimed for a balance between the expertise groups. The researchers continued to recruit individuals until the end of the study (within a strictly defined period of the temporary exhibition, as agreed with the Van Abbe staff). Due to the self-selection of most participants, they were expected to have an above-

average interest in art and to visit museums regularly, which was reflected in a mean interest in art of 6.06 on a 7-point Likert-type scale (SD = 1.12). Furthermore, most of the participants reported visiting art exhibitions often (71%), with a minority stating that they visited art exhibitions only sometimes (21%). Prior to participation, all participants were screened for color blindness using an Ishihara color vision test book.

2.2. Stimuli

As mentioned in the introduction, three paintings were the subjects of this investigation: one of Stella's second group of Black Paintings, *Tuxedo Park Junction* (1960; 311.9 × 187 cm; see Fig. 9 below on the left); one of Stella's Irregular Polygons paintings, *Effingham I* (1967; 327 × 335.5 × 10.1 cm; see Fig. 5 below, top-right, original painting); and one painting from the *Protractor* series, *Hiraqla Variation II* [1968; size of the replica is 250 × 500 cm; size of the original painting is 305 × 609 cm; fluorescent and conventional acrylic (polymer) paint on canvas; see Fig. 7 below, top-right, painted replica].

Both the original painting of *Effingham I* and the painted replica of *Hiraqla Variation II* were shown alongside a printed copy of the respective works. These works were combined with a print so that participants could see the paintings with and without fluorescent colors, as they appear in reproductions (Note 3) and in photographs of the works (except for their reduction in size, with the intensity of the colors and the tactility of the materiality appearing weakened and simplified). We wanted to see how these works would be experienced without fluorescent colors in order to learn more about their impact on the work as a whole. Furthermore, we were curious about which version (the painting or the printed copy) the participants would prefer. We chose to make the copies the same size as the paintings, and they were printed on (white) canvas and mounted on a stretcher frame of the same thickness as the

paintings. As a result, a typical participant did not immediately notice the difference between the two versions upon entering the room. By putting a printed copy of the exact same size, and mounted on a stretcher, next to the paintings, a specific comparison between color and materiality was made possible.

In addition to the fact that the colors appear differently in the printed and painted versions, when comparing them up close, the pixelated surface and glossy structure of the copy is incomparable with the tactility of the matte brushed paint surface of the original painting (see Fig. 3). None of the participants received information about the paintings or were told that they were combined with a printed copy. Participants only knew that the study was based on Frank Stella's work.

2.3. Setup

2.3.1. Exhibition Space

For this study, a temporary exhibition was created in one of the exhibition spaces of the Van Abbemuseum. During the weeks of the study, a special setup with temporary walls was installed in the exhibition space so that the paintings were in three separate rooms (see Fig. 4). This allowed us to counterbalance the sequence in which the paintings were visited across participants. When standing in the exhibition space entrance, the left room consisted of the original painting of *Effingham I* (on the right) and the printed version next to it (on the left) (see Fig. 4). The most remote room was where *Tuxedo Park Junction* was installed, and the room on the right contained *Hiraqla Variation II* (replica) and a printed version next to it (similar to the *Effingham I* room) (see Fig. 4). Half-way throughout the study, the *Hiraqla Variation II* painted replica and print were switched to be able to check whether left to right reading biases had an effect on the preferred first viewing location. All of the paintings were

displayed in rooms with no daylight and lit with 4000 K spotlights. Each room provided enough space for the participants to walk around and comfortably choose a suitable viewing distance (see Fig. 4). Only one person at a time was allowed to enter each room. All rooms had entrances with curtains that opened right between the painting and the copy, or in the center of the painting, in the case of *Tuxedo Park Junction*.

2.3.2. Eye-Tracker

Eye movements were monitored and recorded while participants were wearing a set of Tobii Pro Glasses 2 with a sampling frequency of 50 Hz. The glasses employ a binocular eye-tracking technique using corneal reflection and dark pupil tracking (Tobii Pro, 2020). Before the participants could start the task, they were asked to fixate on one point, as a way to calibrate the mobile eye-tracking glasses (i.e., one-point calibration procedure). Afterwards, the Tobii Pro Lab software (and R) was used to analyze the data. This software allowed us to specify areas of interest (AOIs) on the paintings, enabling the comparison of eye-movement behavior (e.g., number of fixations) between regions of the paintings.

2.3.3. Questionnaires

After the eye-tracking component, each participant was asked to complete a short questionnaire, followed by a short interview regarding the aesthetic appreciation of each work and the copies. In the *Effingham I* room, the participants were asked to rate the color depth of certain areas on the painting and the same areas on the copy. This part of the questionnaire was part of a follow-up study of a previous, more controlled color depth experiment (De Winter *et al.*, 2018) (Note 4). Due to the large number of different colors in *Hiraqla Variation II*, the participants were asked about their (color) depth experience for the replica and the copy during

the interview. This was also done for *Tuxedo Park Junction*. In both cases, if the participant mentioned something or a certain area was pointed at, this was noted and marked by the interviewer on the schematic representation of *Hiraqla Variation II* or *Tuxedo Park Junction*.

In addition to the color depth rating, six different scales were used to assess the participants' aesthetic responses for all of the paintings and copies. The choice of these scales was based on those used in the study by Lyssenko *et al.* (2016). We used four of the Lyssenko *et al.* scales: Structure, Interest, Pleasantness, and Complexity, and added two more scales of special interest to this study: Staticness and Fragmentation. The scales used in our study were as follows: structured–unstructured, interesting–boring, pleasant–unpleasant, simple–complex, static–dynamic, fragmented–unified. Each scale consisted of a five-point line scale with antonyms on opposing sides but no clear markers for discrete numerical responses. For the analysis, we transformed the five-point line into a nine-point scale (with values from −4 to 4 in order to increase specificity and to decrease ceiling and floor effects). Participants marked their response on the line segment from one extreme to another. Responses were recorded based on the value of the point they were closest to on the nine-point scale, using the point of intersection with the scale as the answer value, if the answer was a simple line or tick mark. When responses were given in the form of a cross (or other related characters), the response value was set equal to the scale value above which the center of the cross was positioned (by visual approximation). In the event that an answer was exactly between two points on the scale, the point value to which most of the response mark was closest was used.

2.4. Task and Procedure

First, participants were asked to complete an informed consent form and a short form to register demographics (e.g., age, sex and education), aesthetic interests, and art (historical) education.

After the completion of the form, the participants were invited to conduct the eye-tracking study, consisting of a first part, which was a semi-controlled, fixed eye-tracking experiment, and a second part, the mobile eye-tracking study in the exhibition. The fixed eye-tracking experiment consisted of a visual exploration task around a circle with different colors (based on the *Hiraqla Variation II* painted replica and the printed copy) and a subsequent task in which they were asked to look for one specific target color in the same color circle. This experiment took approximately 15 to 25 minutes to complete and was part of a study on the painting *Hiraqla Variation II*, but is not included in this article. Apart from a few participants noting the presence of fluorescent or neon colors in the stimuli used, the preliminary experiment contained no information related to the research questions of the current study.

Thirdly, immediately following the fixed eye-tracking experiment, the mobile eye-tracking study took place. After calibrating the Tobii eye-tracking glasses, each participant went into the exposition space alone, following a predetermined route. Each participant was given a room order (evenly distributing the following room sequences: 1-2-3; 1-3-2; 2-1-3; 2-3-1; 3-2-1; 3-1-2). Participants were asked to carefully follow the instructed order of rooms and not return to previous rooms during the free-viewing experiment. Furthermore, the participants were instructed to spend as much time viewing the paintings as they wanted. In a few cases, the connection was lost due to a malfunction of the Tobii equipment, causing the participants to be called back for correction when they left the room. Consequently, in those cases, the last parts of the viewing experience were lost, as the participants were instructed not to revisit the room where the disturbance occurred (participants were able to revisit the room after the eye-tracking phase). After visiting the three rooms, the recorded file was saved and the eye-trackers were taken off.

Thereafter, all participants were invited for an interview in which they were asked in each room to fill in a one-page questionnaire for each painting and copy. During this phase,

participants revisited the works in the presence of the interviewer. First, all participants were asked about their experiences in the *Effingham I* room, in which they all began by completing the color depth part, followed by the aesthetic response questionnaire (scales). The participants alternately started with the original painting and the copy. After the participant finished the questionnaire (for both the painting and the printed copy) in one room, the interviewer further interviewed the participant on his or her viewing experiences, asking questions about whether they noticed a difference between the two versions (in the case of *Effingham I* and *Hiraqla Variation II*), if they could experience the work in an instant, and whether they experienced depth (in the case of *Hiraqla Variation II* and *Tuxedo Park Junction*). At the end of each interview session, the participant was asked to select his or her favorite painting. All answers were written down on the fill-in sheets of the questionnaire. When one room was finished, the interviewer guided the participant to the next rooms, in which the procedure was repeated. The room order, after revisiting *Effingham I*, was randomized across participants. When the interview was finished, all participants received a general debriefing. They did not receive specific information, like the fact that the original painting was combined with a printed copy or that *Hiraqla Variation II* was a painted replica, in order to prevent them from passing on such information, which might compromise the data acquired from subsequent participants. They were promised more information after the finalization of the analysis of the data and were invited to attend an upcoming symposium (which took place in the Van Abbemuseum a week after the experiment ended).

This study was approved by the Social and Societal Ethics Committee (SMEC) at the KU Leuven.

2.5. Technical Information on Heatmaps

The gaze fixations were extracted from the raw data using the built-in Tobii I-VT filter (Velocity-Threshold Identification Gaze Filter) with default parameters for the 'Attention' version of the algorithm (Tobii Pro, 2021, p. 159), including a velocity threshold of 100°/s and a minimum fixation duration of 60 ms.

To provide a better visual understanding of how participants' gaze fixations were distributed across the paintings and copies, we created relative heatmaps of the fixation distributions using the 'Heatmap' feature in Tobii Pro Lab. A heatmap displays the relative distribution of the fixations on a given image (these can be per participant or pooled across groups). The warmer colors represent the more-attended areas in the image, while the cooler colors represent the less-attended areas. The 'Heatmap' feature in Tobii Pro Lab counts the fixations at each location of the image to provide a spatial distribution of the gaze fixations, and smoothens it with a cubic Hermite spline polynomial function (approximating a Gaussian smoothing kernel). We used the default parameters implemented in Tobii Pro Lab, i.e., the radius of the cubic Hermine spline function was set to 50 pixels (for a resulting kernel of 100 pixels) and the time of interest included the total viewing time for each artwork. We computed relative heatmaps, which incorporate a normalization by participant. Each participant's fixation count at each location is divided by the total number of fixations they executed, before smoothing the map aggregating the participants' fixations. Therefore, relative heatmaps are less influenced by participants with an extreme number of fixations than absolute heatmaps, which pool the fixations of all the participants together without normalization.

3. Results

In this section, the results of the mobile eye-tracking, questionnaires and interviews are discussed.

3.1. A Comparison Study of the Eye-Movement Behavior for the Original Painting vs Printed Copies in Effingham I (1967) and Hiraqla Variation II (1968)

In this subsection, the relative heatmaps along with the mean proportion of fixations will be discussed for both versions (original painting and printed copy) of *Effingham I* and *Hiraqla Variation II*. As mentioned above (see Subsection 2.1), 98 of the total of 103 participants conducted the eye-tracking study, although only 92 complete recordings were usable (error-free). Thus, the heatmaps are the result of 92 different recordings, of which 32 stem from laypersons, 41 from artists, and 19 from art historians.

3.1.1. Effingham I, Original Painting vs Printed Copy

When comparing the heatmaps of the original painting and printed copy of *Effingham I* (Fig. 5) it initially appears that they show fairly similar viewing patterns. In both versions, it seems that there are more fixations on the yellow part than on the orange part. More fixations can be noted at some of the corners of the yellow diamond shape in the original painting of *Effingham I*. In addition, the lower left corner and the point angle in the cove at the top received many fixations in both versions. In the case of the copy, the point corner appears to show more fixations, likely because the canvas was wrinkled in that spot and thus attracted more attention from the viewer, whereas the wrinkling was not present in the original painting.

The fact that, in general, certain corners of both the original work and the copy received the most fixations might indicate that the corner points of the structure of the painting (the depicted shapes and bands, which are emphasized by the literal shape) are drawing the eye more than, for example, a single (fluorescent) colored plane. On both the original painting and the printed copy, small fixation clusters appear in the middle of the yellow plane. When zooming in on the image of the original painting, it appears that these clusters are caused by

580 the presence of certain impastos. These impastos turned dark on the reproduction due to the
581 shading of the structure, which apparently attracted the attention of participants. As in the case
582 of the wrinkles in the pointed corner of the copy, they caused an increase in the number of
583 fixations on those areas.

584 Furthermore, in both versions, a strong distribution of the fixations over the entire
585 surface can be noticed, with the exception of the upper part of the orange and blue planes. The
586 latter is likely because, due to its size, the work could not be properly fixated in its most
587 peripheral parts (or with a limitation of the eye-tracker to pick up such extremely peripheral
588 fixations).

589 To determine whether a particular version (i.e., the original painting with fluorescent
590 colors or the printed copy with only conventional colors) received more fixations, a mixed-
591 design analysis of variance (ANOVA) was conducted. The means and standard deviations for
592 the proportions of fixations (number of fixations on an area divided by the total number of
593 fixations for the participant) were calculated for both versions as within-subject variable, and
594 for expertise group as between-subject variable (see Fig. 6).

595 Mixed-design ANOVA shows a main effect of painting type [$F(1, 88) = 5.14$, $p < 0.05$]
596 and an interaction effect between painting type and expertise group [$F(2, 88) = 6.14$, $p < 0.005$].
597 Post-hoc Tukey pairwise comparisons indicate that only artists and art historians fixated more
598 on the original painting than the printed copy [$t(88) = 2.93$, $p < 0.01$; $t(88) = 2.42$, $p < 0.05$,
599 respectively], while laypersons did not significantly fixate more on a specific painting type;
600 rather, based the averages, the trend even seems to be in the opposite direction.

601

602 *3.1.2. Hiraqla Variation II Painted Replica vs Printed Copy*

603 In both heatmaps, a more or less even distribution over the entire central part of the pictorial
604 surface is apparent (from left to right; fewer fixations are noticeable at the top and bottom part).

Specifically, it seems that participants focused the most on the individual-colored bands in the central area of the painting. When comparing the heatmaps of the copy and the painted replica of *Hiraqla Variation II* (Fig. 7) it is noticeable that the copy received fewer fixations than the replica (see further, Subsection 3.3). In the heatmap of the painted replica, it appears that most fixations are distributed in the zones around the three central focal points in the configuration (intersections where four frame segments meet). The latter is also the case for the copy, but is less pronounced, with significantly fewer fixations in the central part of the painting.

Observing the heatmap of the painted replica it appears that the areas around the central points of the cross-sections received more fixations. Furthermore, when focusing on the color type (conventional vs fluorescent), it seems that the zones on the heatmap with the most fixations coincide with colored bands that are purely fluorescent or a fluorescent hue mixed with white: the small fluorescent pink area on the left, the fluorescent orange/white of the square-shaped frame, the top part of the fluorescent orange arc, the corner of the quarter circle frame in fluorescent pink/white, and the pure fluorescent green and yellow in the right semi-disk received the most attention. In addition to the fluorescent hues, the dark blue small semi-circle band in the right middle part and the light blue semi-circle band in the rightmost semi-disk also received a large number of fixations. The same locations as those on the painted replica also received the most fixations on the copy, although the heatmap shows somewhat lower numbers of fixations. The video footage showed that participants often went back and forth between both versions, which might indicate that participants were comparing the colored planes of both versions, although they fixated more frequently on the more intensely colored bands of the replica.

Visual inspection of the proportion of fixations on the graph above (see Fig. 8) reveals that artists and art historians seem to fixate more on the original painting than laypersons do. The ANOVA confirmed these expectations by finding a main effect of painting version [F(1,

88) = 31.19, $p < 0.0001$] and an interaction effect between group and painting [$F(2, 88) = 4.97$, $p = 0.009$]. Post-hoc Tukey pairwise comparisons indicate that artists and art historians fixated more on the original painting than on the printed copy [$t(88) = -5.534$, $p < 0.0001$; $t(88) = -3.629$, $p = 0.0005$; respectively], whereas laypersons distributed their fixations more equally across both versions.

From the comparison of the heatmaps and the fixation counts between expertise groups for *Effingham I* and *Hiraqla Variation II*, it can be concluded that in both cases, more fixations went to the painted versions, with *Hiraqla Variation II* generally showing the strongest difference between versions, likely due to the effect of the fluorescent colors. Moreover, in both cases, the experts focused less on the copies than the laypersons did. Laypersons distributed their fixations more equally over both versions, and in the case of *Effingham I*, they seemed to focus even more on the copy than on the original painting (but this may be due to some artifacts in the printing and mounting).

3.1.3. Tuxedo Park Junction

When compared to those of the other two works, the heatmap of *Tuxedo Park Junction* (1960) seems much more pattern-driven due to the monochrome black color. In this heatmap, it is particularly significant that the three central points in the pattern of the painting received the most fixations (see Fig. 9). Furthermore, the indication of three virtual (or illusory) horizontal lines caused by the alignment of the corners of the open canvas lines becomes strikingly visible on the heatmap.

3.2. Preference Analysis (Interview Data)

In order to learn more about the aesthetic appreciation of works by the participants, after the eye-tracking task, they were asked to complete a questionnaire and were interviewed on their experience. First, we will discuss the overall preference of all observed works (including copies), and second, we will examine the preference differences between original painting and printed copy in both rooms. In both of these cases, any differences between the expertise groups will be specified as well.

3.2.1. Preference for Specific Art Works

At the end of the interview, all participants were asked about their 'absolute' preference among all of the works they had observed. Among all three works (considering original paintings and printed copies together as one work; see Table 1), most participants preferred *Tuxedo Park Junction* (41%) (Note 5), then *Hiraqla Variation II* (35%), with *Effingham I* being the least preferred (12.5%). In evaluating group differences, it appears that in the expert groups, the majority preferred *Tuxedo Park Junction* [artists (44%) and art historians (37.5%)]. Laypersons preferred both *Tuxedo Park Junction* (39%) and *Hiraqla Variation II* (44%), with a slightly greater preference for the latter. Furthermore, it is striking that *Effingham I* came out as the least preferred work in all groups (i.e., the only original fluorescent painting in the Van Abbe collection).

The first reason for the strong preference for *Tuxedo Park Junction* may be the fact that a number of participants were already familiar with the work. When asked about their knowledge of the works, 40% of the participants indicated that they had seen *Tuxedo Park Junction* before, while only 20% claimed to have seen *Effingham I* before and only 18% had previously seen *Hiraqla Variation II*. Furthermore, 51% of the participants who had already seen *Tuxedo Park Junction* also preferred the work over the other two paintings, while no such effects were found for the other paintings.

The second reason for the stronger preference for *Tuxedo Park Junction* could be linked to the educational background of the participants. We found that 78% of the participants who had attended higher or university education preferred *Tuxedo Park Junction*, while 50% of the participants with lower educational attainment preferred *Hiraqla Variation II*. For *Effingham I*, no such effects could be found.

Finally, beside bias effects, we speculate that there might be intrinsic painterly aspects that could have favored *Tuxedo Park Junction*, such as its simplicity, its impressive vertical size, and qualities of the paint process itself (e.g., the brushed surface and the unevenness of the stripes of bare canvas, compared to the more hard-edged lines of the other works). Because we have not explicitly asked about these in the interviews and only few people have mentioned them spontaneously, we have to conclude that all three of these factors have probably contributed to the higher preference for *Tuxedo Park Junction*.

3.2.2. Original Painting vs Printed Copy

When comparing the room visit durations (Note 7) of *Effingham I* with those of *Hiraqla Variation II*, a higher engagement with the *Hiraqla Variation II* versions was detected. On average, participants spent between 100 and 125 seconds in the *Effingham I* room and between 140 and 170 seconds in the *Hiraqla Variation II* room. All groups spent at least half a minute longer in the *Hiraqla Variation II* room.

After participants had filled in the questionnaire (see Subsection 2.3) for both the original painting and the printed copy (in both the *Effingham I* and *Hiraqla Variation II* rooms), they were asked which of the two versions of each work they preferred (note that none of the participants knew that they had been looking at an actual painting and a printed copy). Then, we asked if they noticed any differences between the two versions. We were curious whether participants spontaneously noticed that it was an original painting (or replica) next to a printed

copy, and we also wanted to find out whether this effect was reflected in the relative fixations per participant.

Most participants preferred the original painting over the printed copy (Table 2) for both *Effingham I* (78.5%) and *Hiraqla Variation II* (75%). When comparing across expertise groups, it appeared that approximately 36% of the laypersons preferred the printed copy of both *Effingham I* and *Hiraqla Variation II* over the original painting. Among the art historians, 25% preferred the copy of *Hiraqla*, while only 8% preferred the copy of *Effingham I*. The group of artists showed a stronger preference for the original painting in both cases (84% and 88%, resp.).

Here, it is interesting to further investigate to what extent the participants were aware that they chose between a copy and the painted (original) version. After participants had named their preference for one of the two versions, they were asked about the reason for their choice and whether they noticed differences between them. In analyzing the data, we distinguished between those who spontaneously 'noticed copy and original,' those who 'mentioned a difference' (without specifically saying that it is a copy and an original), and those who 'did not mention a difference' at all.

Comparing between *Effingham I* and *Hiraqla Variation II* (Table 3), it appears that 53% of all participants noticed copy and (painted) original in the case of *Effingham I*, while in the case of *Hiraqla Variation II*, this fraction was significantly lower (28.5%). A comparison between expertise groups indicates that, for both works, a large number of laypersons did not mention a difference between the two versions, especially in the case of *Hiraqla Variation II*. In contrast, the majority of both artists and art historians either noticed that it was the original painting and a printed copy or mentioned a difference between the two versions.

These findings are also in line with the heatmaps and fixation counts (see above). In both *Effingham I* and (most strongly) *Hiraqla Variation II*, fewer fixations were measured in

the copies, a difference which was largely driven by the experts (both artist and art historian groups). Some of the experts focused more on the original painting than on the printed copy, and in some cases, we found that experts barely fixated on the copy, as illustrated in the gaze plot in Fig. 10. The gaze plot of the layperson is distributed more equally, while the expert has more fixations on the original painting. This trend was also found in the interviews. The art historians had the strongest reactions against the copies, describing them as 'worthless' and 'ugly.'

Finally, it is also interesting to note that none of the nearly one hundred participants noticed that *Hiraqla Variation II* was a hand-painted replica.

3.3. A Comparison Study of the Areas of Interest in the Original Painting vs Printed Copy Versions of Effingham I (1967) and Hiraqla Variation II (1968)

This subsection explores areas in both paintings that were designated AOIs so that we could summarize and compare certain eye-movement behaviors that each of these areas received. We started by exploring differences in the number of fixations on both the painting and the copy and examining differences between expertise groups for both paintings. In both works, we were interested in investigating the impact of the fluorescent colors on viewing behavior. In two previous studies on the ability of fluorescent colors to capture and hold attention, fluorescent colors were shown to capture the participants' first fixations and generate longer total fixation times than conventional colors (Schieber *et al.*, 2006).

These findings are similar to the claims made by the Dayglo Color Corporation, that fluorescent colors catch the eye faster, hold attention longer, and have a higher frequency of drawing second looks (Dayglo Corp., n.d.). We expected that, in line with these findings, the fluorescent colors in both *Effingham I* (Fig. 11) and *Hiraqla Variation II* (Fig. 15 below) would catch the

eye, hold attention longer, and receive more second looks (i.e., re-fixations) than conventional colors within the same painting. Furthermore, we were interested in whether differences could be found between the participant groups.

Specifically, we hypothesized that, on average, the (purely) fluorescent-colored surfaces of the original and painted replica would receive more fixations than other surfaces (both the conventional surfaces within the original painting and the surfaces in the printed copies). Since *Effingham I* has only three colored surfaces, the structure is more decisive; thus, we chose to mark each colored plane as an AOI (yellow, orange, and blue; see Fig. 12). In *Hiraqla Variation II*, we expected more fixations in the cluster of pure fluorescent-colored bands. Therefore, all colored bands of the same color type were clustered as a group, for a total of three groups: pure fluorescent (*fluo*), fluorescent + white (*fluo-white*), and conventional (*rest*) color types (see Fig. 12).

Since the different color areas that were set as AOIs in both the *Effingham I* and *Hiraqla Variation II* configurations (see Fig. 12) are not the same size, we had to control for the size of the AOIs. This was done by dividing the proportion of a participant's relative number of fixations on a given surface area by the proportion of that surface area relative to the total area of all surfaces. This measure allows us to compare the proportion of fixations that surfaces receive regardless of the surface area.

3.3.1. AOIs of Effingham I Original Painting vs Printed Copy

A mixed-design ANOVA showed a significant main effect of group [$F(2, 88) = 4.93$, $p < 0.01$] and colored surfaces [$F(2.54, 223.91) = 37.99$, $p < 0.0001$], in addition to a significant interaction between these variables [$F(5.09, 223.91) = 4.04$, $p = 0.001$]. Post-hoc Tukey pairwise comparisons indicated that, when controlled for area size, the yellow surface in *Effingham I* received a significantly higher proportion of fixations than the other surfaces

within the same painting for both painting types (original and copy) (see Fig. 13). An exception is that the difference between the yellow surface and its surrounding blue surface of the original painting was absent in the groups with expertise in art (i.e., artists and art historians) (see Fig. 13). In addition, the copy's yellow and blue surfaces did not receive a different number of fixations in the art historian group. Furthermore, when comparing the proportion of fixations controlled for area size between the blue and orange surfaces in the same painting, we find that the blue surface received more fixations than the orange surface in both painting types [$t(440) = 6.00$, $p < 0.0001$; $t(440) = 6.60$, $p < 0.0001$ for copy and original, respectively]. This effect was found for all expertise groups.

Although evidence was found in favor of the hypothesis that fluorescent planes receive more fixations than non-fluorescent ones in the original painting, as fluorescent yellow and blue received more attention than the conventional orange, it is not only the fluorescent aspect that caused an increase in attention. When comparing the results of both versions, no differences could be found between fluorescent blue and yellow of the original and the non-fluorescent blue and yellow of the printed copy. Therefore, it can be concluded that these findings likely had more to do with color or structure (shape) differences instead of the fluorescent effect.

3.3.2. Areas of Interest of Hiraqla Variation II Replicated Painting vs Printed Copy

By repeated-measures ANOVA, we found a main effect of surfaces [$F(5, 440) = 34.27$, $p < 0.0001$], with no interaction effect between groups and surfaces. Post-hoc Tukey pairwise comparisons indicated that, when corrected for area size, the regular fluorescent painted surfaces of the original (painted replica) *Hiraqla* received more fixations than all other surfaces (including the ones in the copy; all $p < 0.0001$; see Fig. 14).

As in the case of *Effingham I*, the findings were in line with our hypothesis that the fluorescent-colored zones received more fixations after controlling for area size. In contrast with *Effingham I*, here, the results imply a higher attractiveness of fluorescent colors [in the original (painted replica)], as they caused the most fixations of colors when comparing the *fluo* cluster with the other AOIs, both within and between the original (painted replica) and the printed copy, especially in the expert groups (artists and art historians). The fluorescent color cluster in the printed copy also received more fixations than the fluorescent-white group ($p < 0.0001$), but the difference with the conventional colored group was not statistically significant ($p = 0.65$).

3.4. Experience of the Colors (Interview Data)

As indicated in Subsection 3.1, some participants (mostly laypersons) did not mention a difference between the painted original and the printed copy of both *Effingham I* and *Hiraqla Variation II*. Furthermore, more participants noticed the original painting and the printed copy for *Effingham I* than for *Hiraqla Variation II*. When asked further about the differences they noticed, most participants pointed at materiality and color differences between the original painting and the printed copy of *Effingham I*. In the case of *Hiraqla Variation II*, most of them only pointed at color differences.

In order to provide a further comparison between the color appearances of both versions in both rooms, we categorized the data according to whether the participants did or did not mention the presence of 'the strongest colors' in the original painting or the printed copy. In some cases, the answers were not specific; thus, a third category was included.

When comparing the two versions (Table 4), it appeared that most participants experienced the strongest colors in the original versions, with all participants who mentioned

828 a difference experiencing the strongest colors in the painted replica of *Hiraqla Variation II*.
829 Some participants found the colors of the copy of *Effingham I* to be appealing. Here, we found
830 that most of the participants who did not previously mention a difference between the copy and
831 the original in *Effingham I* experienced the strongest colors in the copy. People who did
832 mention a difference experienced the original *Effingham I* as having the most pronounced
833 colors.

834 When the participants were asked about the color differences between the two versions,
835 in the case of *Effingham I*, those who found the copy more appealing mentioned that the blue
836 appeared 'darker' or 'stronger,' the yellow looked 'greener,' and the lines in-between the
837 colored surfaces looked 'whiter.' Those who found the colors of the original *Effingham I* more
838 appealing mentioned that they are 'nicer,' 'fuller,' 'deeper,' 'warmer,' 'more real,' and 'more
839 alive.' Those who found the copy more appealing described the colors of the original as
840 'duller,' 'paler,' and 'not very saturated.'

841 As mentioned above, a much more pronounced effect was found in the case of *Hiraqla*
842 *Variation II*. All participants found the colors of the copy less appealing than the painted
843 version and described them as 'less attractive,' 'weak,' 'pale,' and 'muddy.' In the case of the
844 painted version, they described the colors as 'very intense,' 'highly saturated,' and 'vibrating.'
845 Some used even stronger descriptions of the color effect, such as 'eye-catching,' 'dominant,'
846 'explosive,' 'aggressive,' and 'the first thing that comes in when entering the room' (Fig. 15).

847 In the case of the replica of *Hiraqla Variation II* (referred to as the original) (Table 5),
848 a large number of participants (68%) mentioned the presence of more intense colors, with 26%
849 specifically noticing 'fluorescent' or 'neon' colors. Here, they mostly mentioned fluorescent
850 pink (the full fluorescent small semi-circular band on the left side of the painting) and orange
851 (the full fluorescent large arc on the lower central part of the painting) as the most appealing
852 fluorescent colors, or they pointed at the colors in the half disk on the right (which contains the

cluster of three fluorescent colors). It was striking that, in contrast, none of the participants mentioned anything about the presence of intense, bright neon or fluorescent colors in the original *Effingham I* painting, despite the fact that the painting does contain them (see further Subsection 3.5).

The attraction of the more intense colors in the painted replica of *Hiraqla Variation II* was also noticeable in the relative fixation count of the AOIs. When comparing the full fluo AOIs with the fluo + white and conventional AOIs, it appeared that the fluorescent colors received relatively more focus than the others in the painting and also more than the conventional colors of the copy (see previous subsection).

Participants generally did not notice the intense (fluorescent) colors in *Effingham I* and focused more on materiality aspects. In the case of *Hiraqla Variation II*, on the other hand, the appearance of the fluorescent colors emphasized the color difference between the two versions. Materiality differences were less noticed in this case.

Regarding the materiality differences between the copy and the original of *Effingham I*, in general, the following things were noted: the surface of the copy is 'more glossy,' while the painting is 'more matte,' and the copy is 'pixelated,' while the painting was described as 'brushed with paint,' which participants experienced as 'more real.'

In the case of *Tuxedo Park Junction*, participants provided stronger descriptions of the tactility of the paint surface. Some described the tactile effect as 'a relief structure,' 'engraved marble,' or 'carved wood.' Furthermore, in this work, it was apparent that a number of participants (mostly laypersons) did not see that the lines were bare canvas. Instead, they thought that they were white lines painted on the black paint, or chalk lines drawn on top of it. In general, as expected, the experts gave more descriptions of materiality.

3.5. Main Findings from the Questionnaires and Interviews

During the interview, additional questions were asked about experiences related to the materiality of the works, illusory depth, and instantaneousness.

When analyzing the experiences of instantaneousness (Table 6), it appeared that most of the participants indicated that they did not experience the works instantly, except for *Effingham I*, which yielded 41% participants who claimed to have seen it in an instant.

In the case of *Tuxedo Park Junction*, 59% mentioned the strong light reflection on the top part of the painting, which 39% experienced as disturbing. For some, this was the main reason why the work could not be seen instantly. In the painted replica of *Hiraqla Variation II*, many participants mentioned that the high complexity of the work, caused by the many colors, was the main reason for failing to catch the work in an instant.

Participants were asked to fill in a color depth questionnaire about *Effingham I* (see previous subsection). For *Tuxedo Park Junction* and *Hiraqla Variation II*, the interviewer asked about the participant's spatial experience when observing the works. In *Tuxedo Park Junction*, 25% did not experience depth, while 72% did, with 47.5% even claiming to have experienced strong depth effects, which some compared to the effect of unfolding pyramids. In viewing the painted replica of *Hiraqla Variation II*, 11.5% did not experience depth, while 83.5% did, and 59% claimed to have experienced strong depth effects. Among those participants who experienced depth, 37% said that they had experienced depth mainly through color, while 47.5% experienced depth through both color and pattern.

It was striking that 11.5% of the participants mentioned that the repelling effect of the (fluorescent) colors prevented any experience of depth, while those who experienced depth through color (or color and pattern) often mentioned the outward projection of the fluorescent

colors. The latter often mentioned the difficulty of seeing depth through the configuration (i.e., seeing overlapping circles) due to the many different colors.

Participants who did not experience depth described their experiences as follows: '*the more colors you apply, the more you can have a flat effect*'; '*there is too much going on to make it 3D*'; '*I see no depth, maybe from a greater distance the overlap becomes clearer*'; '*first you think you see globes, but the colors are breaking that experience into pieces*'; '*so many colors that pop out, because of the multitude they cancel each other out.*' Those who claimed to have experienced depth through color mainly experienced a fragmented depth effect for some of the colors, as reflected by the following statements captured during the interviews: '*some of the bright colors are protruding*'; '*some colors jump out*'; '*the frames jump out, especially those in bright colors*'; '*the brown colors cause less depth*'; '*I see depth through colors, the circular structures stand out less, after longer observation the image becomes more fragmented.*' Lastly, for participants who experienced depth through pattern (or pattern and color), they generally experienced a more structured depth, illustrated by the following statements: '*the circles are pushing against each other*'; '*I see more depth because of overlapping circles*'; '*the circles are laying in the back*'; '*I experience the windows (frames) in front of the circles*'; '*the circles overlap with the frames in front and the fluorescent green and pink jump out.*' Almost no-one experienced depth in the copy of *Hiraqla Variation II*.

Finally, in the case of the painted version of *Hiraqla Variation II*, participants were asked whether they experienced the colors as arbitrary or not. The majority experienced a systematicity in the way Stella organized the colors, which participants described as follows: '*I can see a system, a color balance is visible here*'; '*there is a color structure, which is not arbitrary, he clearly thought about this in order to create unity*'; '*I feel that there is a structure: it looks logical, it's not a mess*'; '*the colors fit nicely together, I can see a structure*'; '*it seems*

arbitrary, there are so many different colors used, which makes it feel more emotional and intuitive.'

To conclude, in the data from the scales, we found that, in general, the painted replica of *Hiraqla Variation II* was rated as the most interesting painting, while the printed copy of *Effingham I* was considered the most boring. *Tuxedo Park Junction* was also rated as interesting, particularly by the group of artists. These ratings are somewhat in line with the preferences for the three works (see Subsection 3.2), although the high interest in *Hiraqla Variation II* did not make it the most preferred work, which was *Tuxedo Park Junction*. In general, both copied versions were rated as less interesting than the original paintings. In terms of the level of complexity and dynamism, the painted replica of *Hiraqla Variation II* was perceived as the most complex (mostly due to the colors, as indicated in the first paragraph of this subsection) and the most dynamic, while the printed version of *Effingham* was rated as the simplest and the most static. The levels of interest, complexity, and dynamism seem to be linked. Finally, *Tuxedo Park Junction* was rated as the most unified work, although some of the experts found the printed copy of *Hiraqla Variation II* to be the most unified. Based on the previously mentioned descriptions of color depth, some fragmentation was experienced in the painted version of *Hiraqla Variation II*, but no such effect could be found in the data from the scales.

4. Feeding Back into Art History

In this last section the findings of the Tracking Frank Stella study will be summarized and viewed in light of Stella's claims concerning the anti-illusionism of his works.

4.1. All-Overness

When comparing the heatmaps of the three paintings, *Tuxedo Park Junction* showed the highest viewing coherence, with the most fixations located around the three central points of the pattern. Despite the all-over pattern (the stripes run edge to edge), the strong attraction to the three central points reveals that Stella's aim for an all-over viewing experience was not reached. In contrast, this experience seems to be achieved in both *Effingham I* and *Hiraqla Variation II*, as the heatmaps for these works showed a more widespread distribution of fixations, guided by both the shapes and the colors.

The fluorescent surfaces of the painted replica of *Hiraqla Variation II* received the most fixations (when corrected for area size) compared to the other colors in the work and all of the colors in the printed copy. From this finding, together with the fact that the fluorescent colors are distributed throughout the work, it might be hypothesized that the DayGlo colors are (partly) responsible for producing the all-over viewing experience. If this is true, then Stella succeeded in his aim to preserve the sense of all-overness through an equally distributed color intensity.

4.2. Flatness

With respect to (color) depth experience, in both *Tuxedo Park Junction* and the painted replica of *Hiraqla Variation II*, a large number of participants experienced depth, with the strongest depth effects being experienced in the latter. Depth in *Tuxedo Park Junction* was mainly created by the pattern (i.e., unfolding pyramids), while in *Hiraqla Variation II*, it was created mainly through color. Overall, participants experienced the least depth in *Effingham I*.

For the painted replica of *Hiraqla Variation II*, both those who did and those who did not experience (strong) depth effects attributed this to the fluorescent colors. For the latter

group, the intensity of the fluorescent colors was perceived as repellent. Those who did experience depth mostly experienced the fluorescent colors as protruding. This difference in depth experience seems once again to undermine Stella's aim for a uniform viewing experience. However, Stella's aim for flatness seemed to be achieved for those who did not experience depth, who attributed this to the repellency of the fluorescent colors.

The protruding effect of the fluorescent colors, as noticed in the painted replica of *Hiraqla Variation II*, corresponds to the findings of the more controlled color depth study (De Winter *et al.*, 2018). For *Effingham I*, we could compare the results of the previous study with simplified stimuli (same colors but juxtaposed panels instead of complex shapes) with those of the real work in an exhibition here (Note 3). From the analysis, which is not described in this paper (see De Winter, 2020), it was striking that the fluorescent yellow and blue planes in the original painting did not generate depth effects, while they did create these effects in the stimuli of the previous more controlled study.

4.3. Self-Referentiality

Regarding the descriptions of the materiality, in the case of *Tuxedo Park Junction*, most participants experienced the strong gloss as disturbing because it caused a strong light reflection that complicated the visibility of the painting as a whole. For some, the harshness and thickness of the paint surface looked like engraved marble or wood. Not all participants recognized the open spaces in-between the paint stripes as bare canvas; some perceived them as white paint or chalk on top of the black paint layers. These findings go against Stella's self-referential logic, because the atypical visual aspects caused by the specific materiality were not recognized as such.

In the case of both *Effingham I* and *Hiraqla Variation II*, the participants compared the original painting or the painted replica with the printed copy version. Although no fluorescent effect was mentioned for *Effingham I*, more differences in materiality or tactility were noticed in this work. However, unlike for *Tuxedo Park Junction*, no descriptions that indicate the presence of an atypical, synthetic materiality were given here. For the *Hiraqla Variation II* pair, an opposite effect was found: more emphasis was put on the strong color differences, and almost no differences in materiality were noted. For example, the strong color effect of the painted replica of *Hiraqla Variation II* was frequently mentioned, while no-one said anything about the transparency or tactility of the paint layers. The strong fluorescent colors seem to overshadow the other material qualities, which would indicate that the material aspects are not capable of counterbalancing the depth effects caused by the fluorescent colors, as Stella intended. The fact that the fluorescent colors and the other visual aspects specific to this paint type are not jointly experienced brings to light another dissonance that undermines Stella's logic of flatness through actual (fluorescent) materialities.

In the case of *Effingham I*, the absence of a noticeable fluorescent effect, leading to a diminished depth experience and a higher visibility of the materiality of the work, seems to cause the 'flat and frontal' experience that Stella aimed for. A comparable dissonance applies here, although opposite to that in *Hiraqla Variation II*: there, the strong fluorescent effect overshadowed the other material qualities, while here, the fluorescent effect that is needed to generate the self-referentiality of the paint layers was absent. This is probably due to the aging of the fluorescent paint layers. Fluorescent pigments start to degrade after only ten years, causing a loss of fluorescent effect (De Winter, 2010). Therefore, once again, the two types of aspects that give the paint its self-referential quality cannot be jointly satisfied.

4.4. Instantaneousness

Among the three works, *Effingham I* was experienced as the most instantaneous. In the case of *Tuxedo Park Junction*, participants found that the strong light reflection on the top part of the painting prevented a fast capturability of the work. For the painted replica of *Hiraqla Variation II*, the lack of fast capturability was attributed to the complexity of the work. Stella's intention to achieve instantaneousness therefore seems to be confirmed only for *Effingham I*, not for the other works.

4.5. Original Painting vs Printed Copy

The study of the relative heatmaps along with their mean proportion fixations showed that the (original) paintings (*Effingham I* and the replica of *Hiraqla Variation II*) received more fixations than the printed copy. Here we found that experts tend to focus more on the original painting, while laypeople more equally distribute their fixations on both versions. It appeared (from the information gathered through the interviews) that a number of laypeople did not notice that it was a printed copy next to a (original or replicated) painting. Furthermore, nobody noticed that the painted version of *Hiraqla Variation II* was a replica. In general, participants preferred the original painting above the printed copy for both *Effingham I* and *Hiraqla Variation II*. However, a large number of laypeople preferred the printed copy of *Effingham I* above the original painting because of the 'intensity' of the colors. The latter is striking as the original *Effingham I* was painted with (much brighter) fluorescent colors. Since the reverse effect was found for the two versions of *Hiraqla Variation II* (the copy was found less bright than the freshly painted replica), this might indicate a strong degradation of the paint layers of *Effingham I* due to aging. Furthermore, when participants were asked to describe the differences between the two versions (*Effingham I* and *Hiraqla Variation II* rooms), more

materiality differences were noticed in the case of *Effingham I* and more color differences in the case of *Hiraqla Variation II*. This reverse effect once more indicates a difference in appearance of the fluorescent paint layers in *Effingham I* due to aging.

4.6. Expertise

As mentioned in the introduction, according to Stella, factors like personal preference, bias, and connoisseurship should not interfere with the viewing experience. However, we found that differences in expertise lead to varying experiences, especially with regard to materiality and preference. In all the paintings, laypeople mentioned fewer material qualities than experts and, in general, they did not seem to experience the specific material qualities that Stella intended. Also, beside the abovementioned expertise difference in terms of fixation counts (see Subsection 4.6), laypeople were not as proficient in distinguishing the original painting from the printed copy (for both *Effingham I* and *Hiraqla Variation II*).

Finally, the preference ratings revealed that *Tuxedo Park Junction* was the most preferred work. It turned out that a large number of participants had seen the work before, which may indicate a mere exposure bias or familiarity effect. The painted replica of *Hiraqla Variation II* received a preference rating that was only slightly inferior to that of *Tuxedo Park Junction*, while *Effingham I* was the least appreciated work. Here, education was a determining factor: people with higher education generally preferred *Tuxedo Park Junction*, while *Hiraqla Variation II* was preferred by those who had not gone through higher education.

In general, it must be concluded that Stella's intended uniformity of experience has not been achieved. Moreover, a number of dissonant findings were obtained, particularly in the fluorescent works, which reveal an internal tension between factors that were intended to jointly instantiate Stella's logic. Whether these dissonances and lack of uniformity can be

extrapolated to the rest of Stella's work of the sixties remains to be seen and will hopefully be the subject of future work.

4.7. Discussion and Conclusion

The methodology applied in this research consists of an empirical approach to some art-historical questions related to Frank Stella's fluorescent works of the 1960s, in which some perception claims about these paintings were isolated and subjected to an depth investigation. The tested claims, which were made by the artist and art critics, were presented as being universal, in the sense that they should obtain for any viewer who is confronted with a work to which a claim is applicable. This appeal to universality is problematic: the claims attributed to Stella's work have been shown not to be applicable to all subjects. Moreover, they overlook some of the complexities involved in the viewing experience of works of art, particularly those containing fluorescent colors.

Note that this approach also has its difficulties. Firstly, the main difficulty is to adequately isolate and translate claims from one domain of discourse to another (namely from art theory to vision science), and to consequently operationalize them into questions that can be tested adequately. Beside the 'reduction' that stems from this translation, by isolating and operationalizing claims, they are removed from the original context in which the artist/art theorist uttered them, and therefore artificially detached from a complex of presuppositions, background experiences, art-historical knowledge, etc.

Secondly, some comments can be made regarding the design of the study: only three works have been tested (of which one is a replica), each one selected from a larger series. In order to draw firm conclusions about Stella's Modernist logic, the study would have to be repeated with other works of the same series. Also, the rooms where the works (and printed copies) were presented were rather small. Ideally, such studies should be conducted in larger

rooms to provide a viewing experience that matches the conditions in which the works were originally shown.

Finally, we found that the condition of the works has a great impact on the outcome of the study. Because of the degradation of the fluorescent colors in *Effingham I* due to aging, we had to conclude that the original effect is no longer measurable. As a result, *Effingham I* has been disqualified, because the transformed work can no longer meet Stella's original intentions. The latter finding calls for further investigation and it should be ascertained to what extent Stella's other fluorescent works have aged in a similar way. In the case of *Effingham I*, alternative ways of conservation should be considered, such as accurately describing the original visual effects and showing a replica with fresh paint.

Overall, the main lesson that can be drawn from this study is that one should be cautious when being confronted with subjective claims that may be based more on normative theories than on first-person phenomenology by trained observers who look at the actual art works instead of reproductions. It can serve as an eye-opener for future art historians and -researchers: the study indicates a need for greater caution with art-historical claims like the ones at issue here.

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Notes

1. The replica was made slightly smaller than the original to avoid copyright infringement.
2. In this paper (especially in Section 3. *Results*), there will be frequent mention of differences between the 'original (painting)' and '(printed) copy' for *Effingham I* and *Hiraqla Variation II*. For the former, 'original' refers to the *Effingham I* (1967) painting, and for the latter, 'original' refers to the hand-painted replica of *Hiraqla Variation II*.
3. We are aware that the normal size of reproductions of the works that people see in books or on Google Images is much smaller than the original painting.
4. The color depth rating analysis of *Effingham I*, which is a follow-up study on De Winter *et al.* (2018), is not included in this paper; it will be published in a separate publication.
5. All percentages are rounded to one decimal place.
6. N/A represents the number of missing values in the data (participants without ET data).
7. We decided not to compare these visit durations with those of *Tuxedo Park Junction* because this work was shown on its own, without a printed version next to it.

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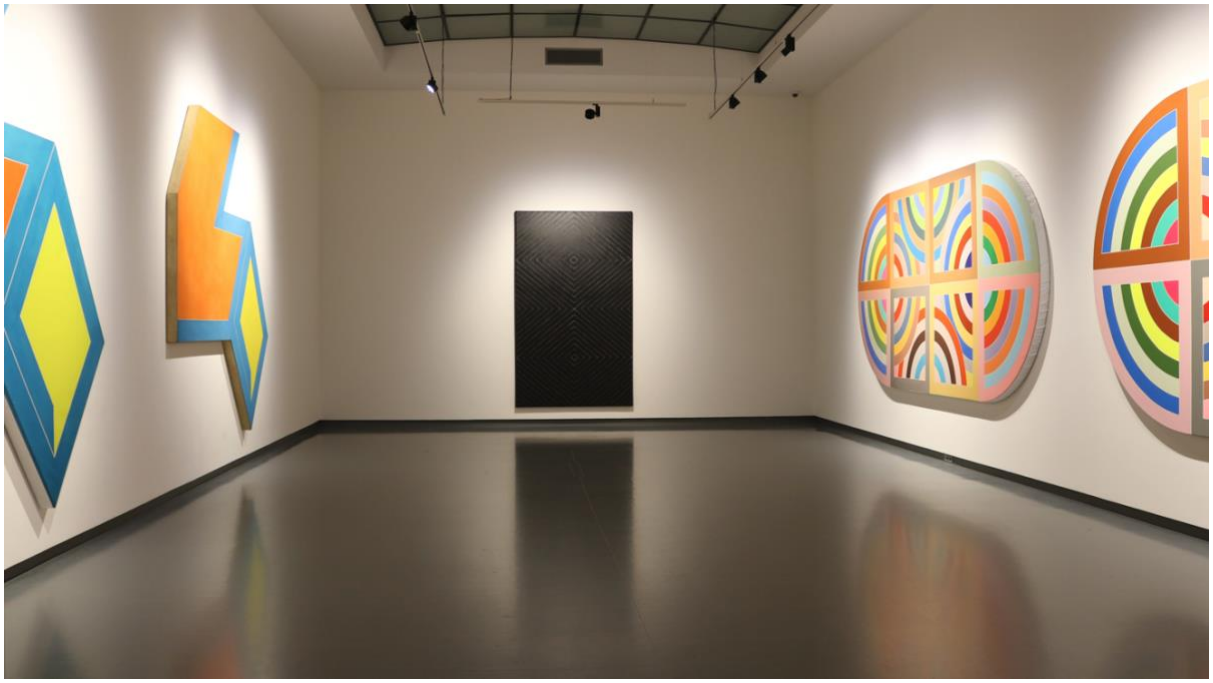

Figure 1. View of the *Tracking Frank Stella* exhibition in the Van Abbemuseum. Source: Photograph by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

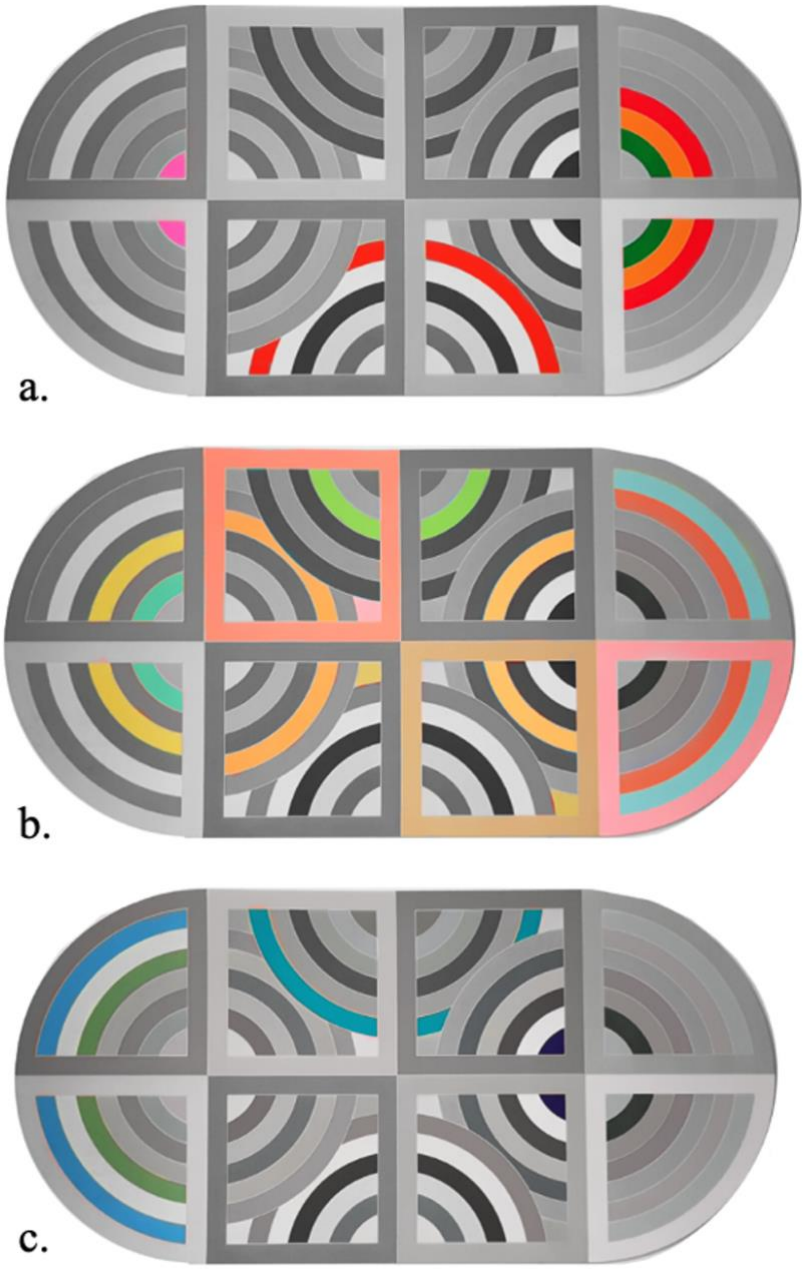

Figure 2. (a) All bands that contain pure fluorescent colors. (b) All bands that contain fluorescent colors mixed with white. (c) All bands that contain fluorescent colors mixed with a conventional hue. (d) Image of the right half-circle part of *Hiraqla* photographed with museum light. Source: Photographs by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

Figure 3. (Left) Detail of printed version of *Effingham I* (1967). (Right) Detail of the original painting of *Effingham I* (1967). Source: Photographs by De Winter.

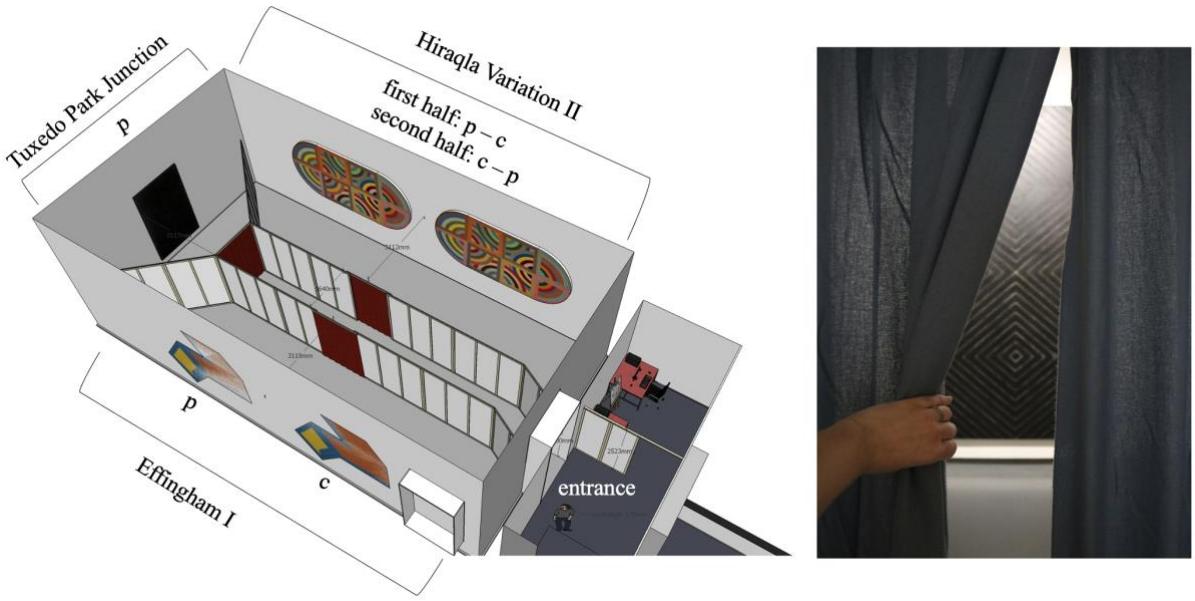

Figure 4. (Left) Floor plan of the setup/exhibition with all stimuli (p = painting, c= printed copy). (Right) Image of a participant entering the room where *Tuxedo Park Junction* was displayed during the experiment. Source: Photograph by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

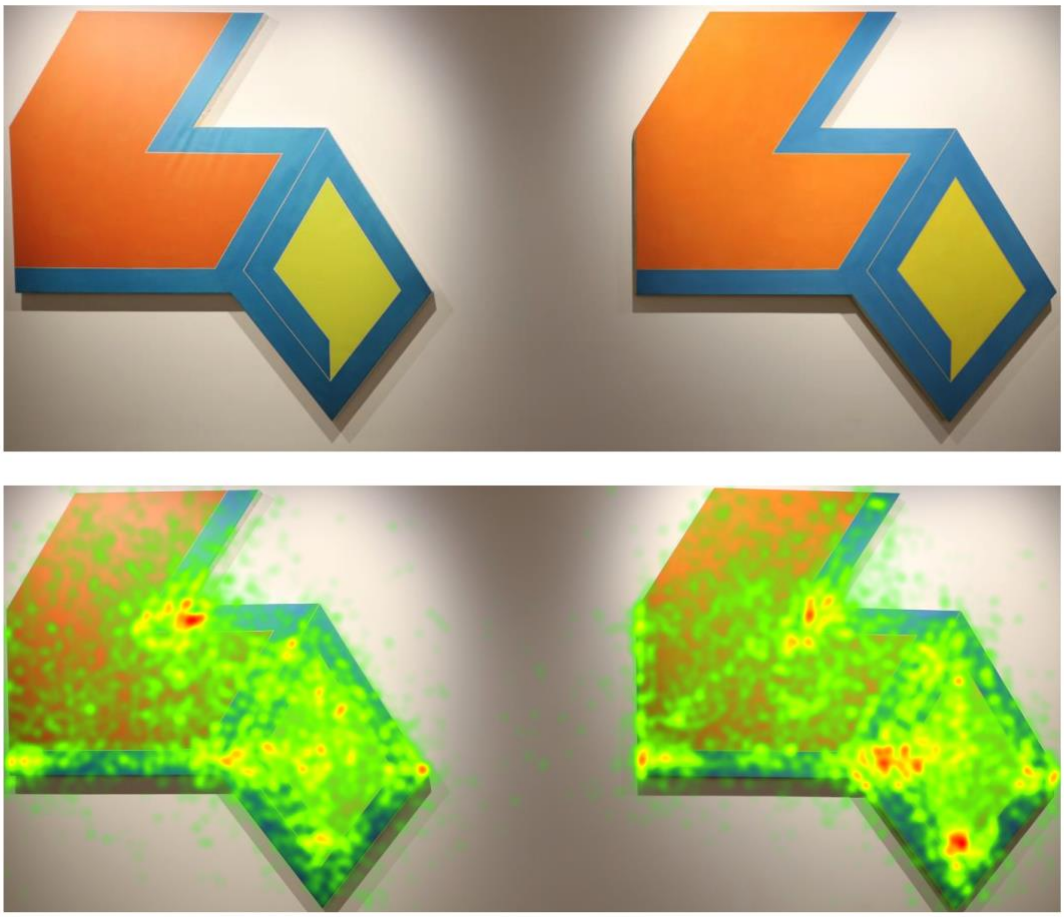

Figure 5. (Top left) Printed copy. (Top right) Original painting of *Effingham I*. (Below) Relative heatmaps of all participants. (Bottom left) Printed copy. (Bottom right) Original painting of *Effingham I*. Source: Photographs by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

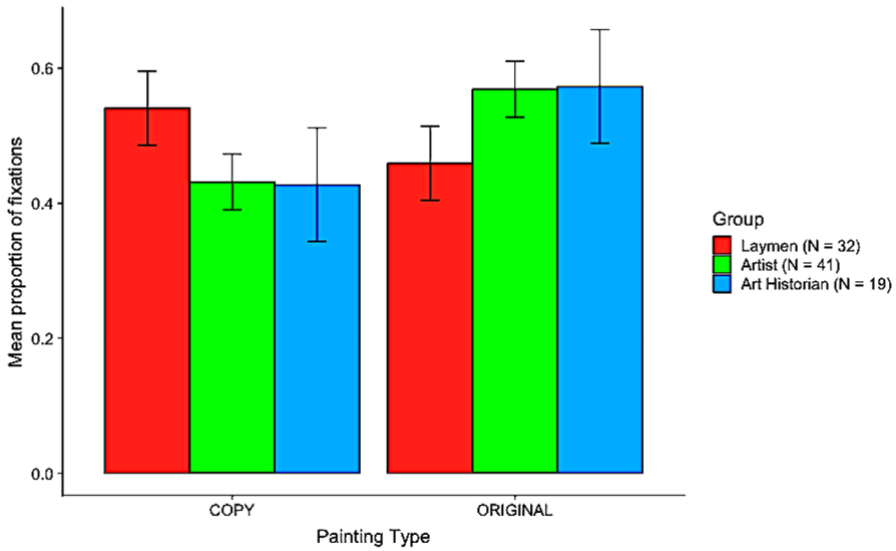

Figure 6. Mean proportion of fixations per painting type for each expertise group. Error bars are ±2SE.

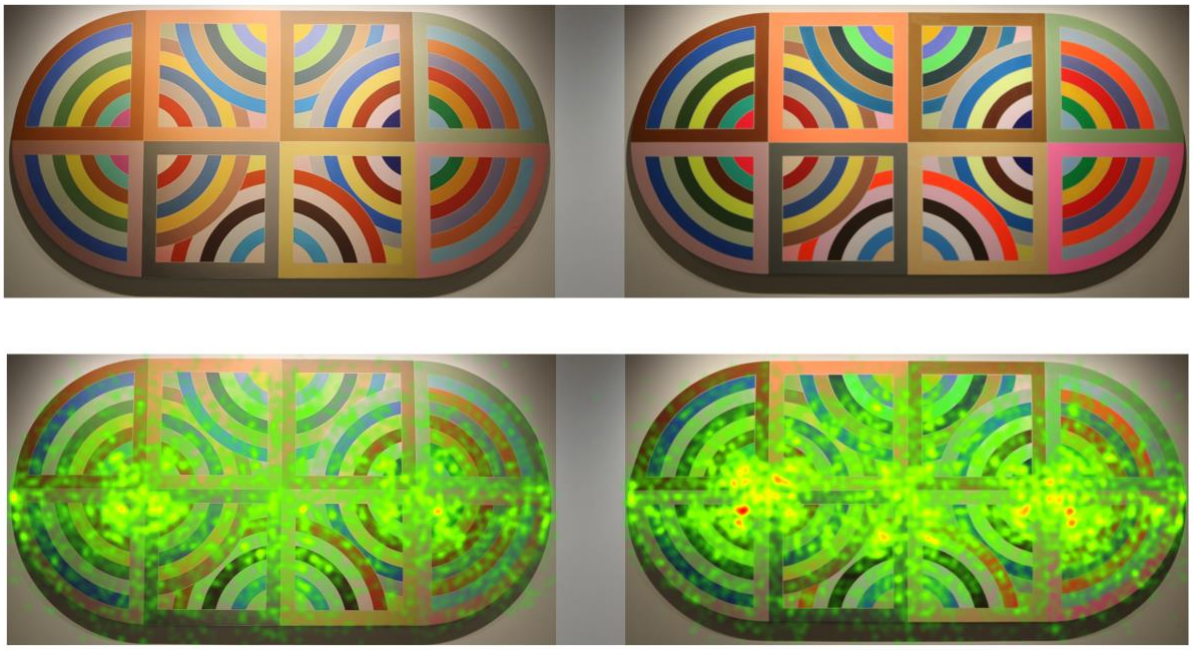

Figure 7. (Top left) Copy. (Top right) Painted replica of *Hiraqla Variation II* (1968). (Below) Relative heatmaps of all participants. (Bottom left) Copy. (Bottom right) Painted replica of *Hiraqla Variation II* (1968). Source: Photographs by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

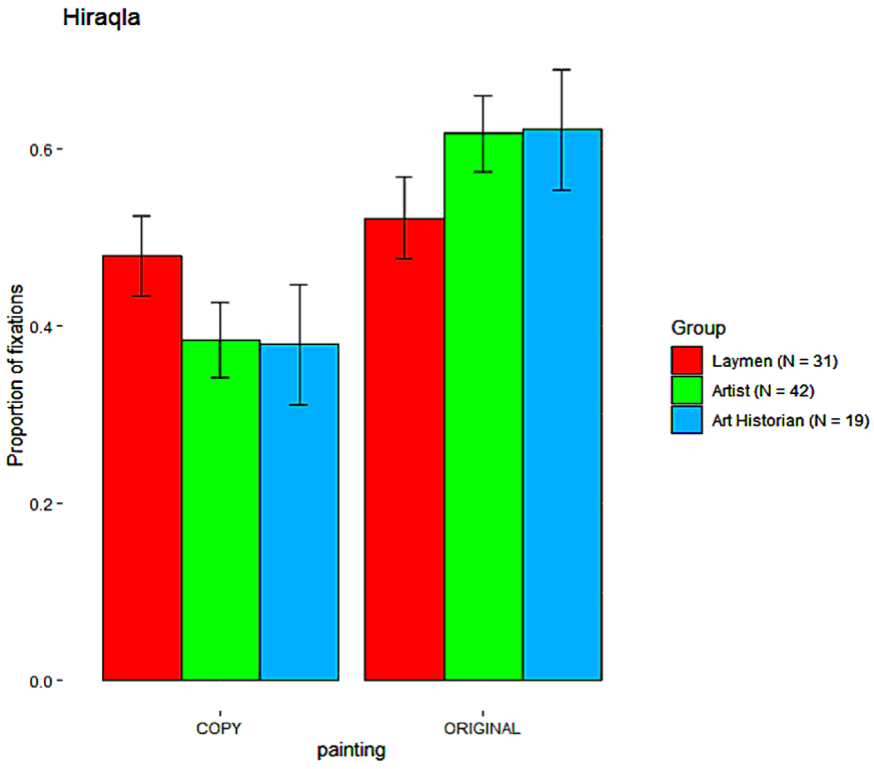

Figure 8. Mean proportion of fixations per painting type for each expertise group. Error bars are ±2SE.

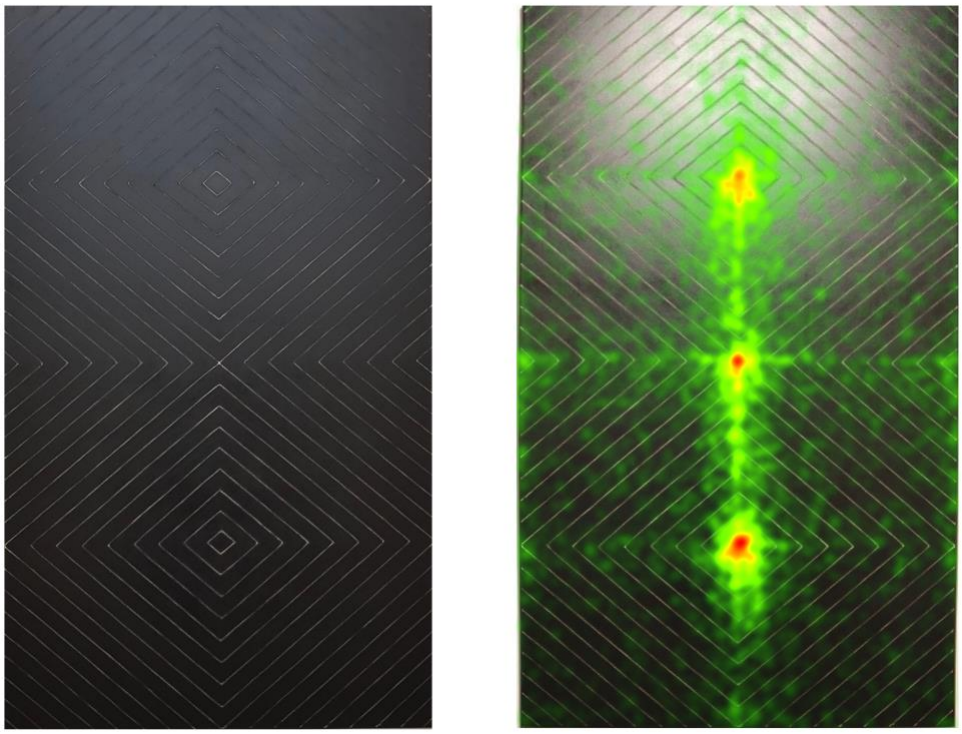

Figure 9. (Left) *Tuxedo Park Junction* (1960). (Right) Heatmap of all participants for *Tuxedo Park Junction* (1960). Source: Photographs by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

Figure 10. (Top) Gaze plot of a layperson observing the painted replica (right) and the printed copy (left) of *Hiraqla Variation II*. (Bottom) Gaze plot of an art historian observing the copy (left) and the replica (right) of *Hiraqla Variation II*. Source: Photographs by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

Figure 11. Image of the original painting (right) and printed copy (left) of *Effingham I* under dimmed UV light. Source: Photograph by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

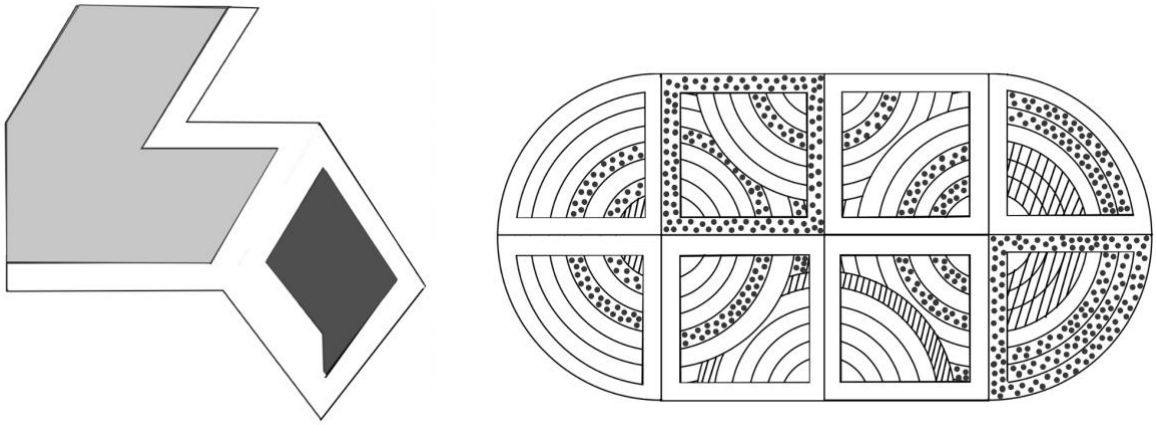

Figure 12. (Left) Areas of interest (AOIs) of *Effingham I*, with each color being one AOI: yellow (dark gray), blue (white), and orange (light gray). (Right) AOIs of *Hiraqla Variation II* (stripes = fluorescent, dots = fluorescent-white, white = rest).

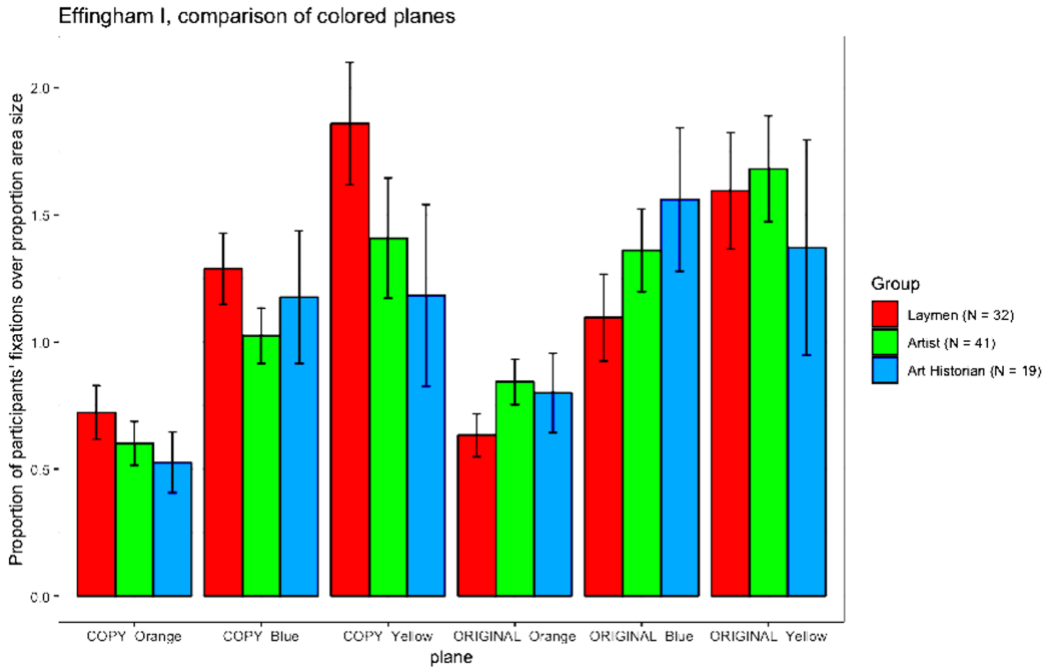

Figure 13. Mean proportions of participants' fixations over proportions of area size for all colored planes by group. Error bars are ±2SE.

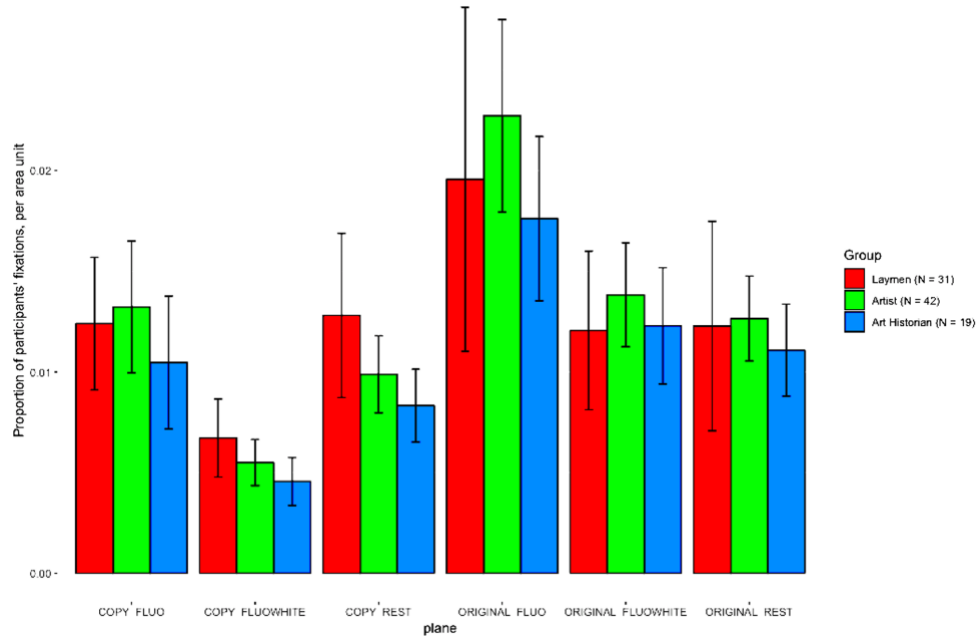

Figure 14. Bar plot of mean proportions of participants' fixations over proportions of area size for all fluo/fluo-white and rest planes, by group. Error bars are ±2SE.

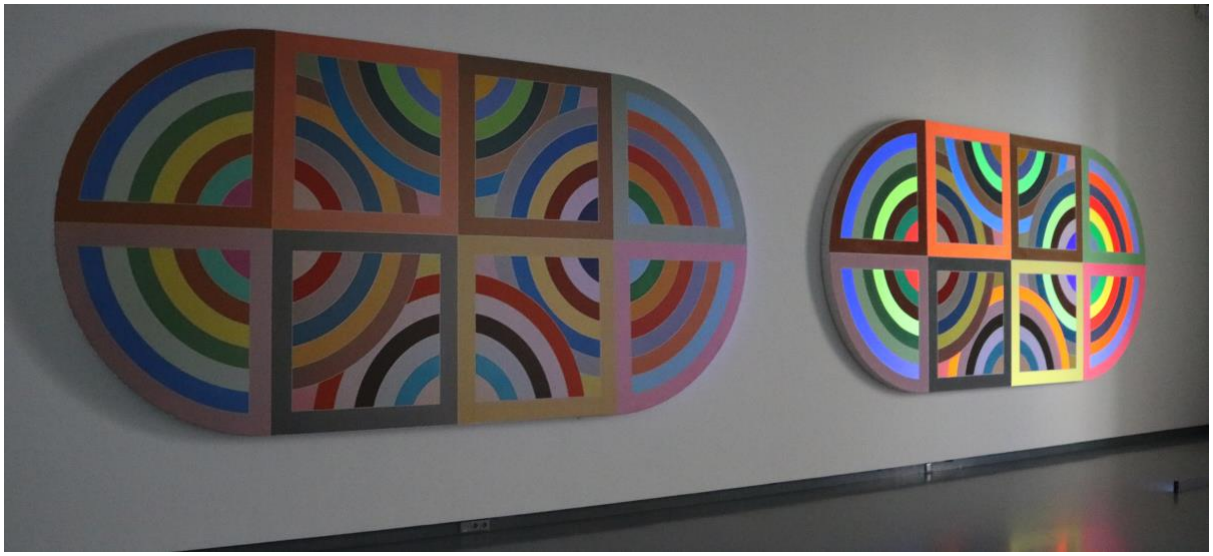

Figure 15. Image of the painted replica (right) and printed copy (left) of *Hiraqla Variation II* in dimmed UV light. Source: Photograph by De Winter. Art © Frank Stella (© SABAM Belgium 2022).

Table 1.

Numbers of participants (total and by groups) preferring each painting.

	Total (n = 103)	Laypersons (n = 36)	Artists (n = 43)	Art historians (n = 24)
N/A (Note 6)	*12*	*4*	*3*	*5*
Effingham I	13	2	7	4
Tuxedo Park Junction	42	14	19	9
Hiraqla Variation II	36	16	14	6

Table 2.

Number of participants (total and by groups) preferring actual painting or printed copy (for both *Effingham I* and *Hiraqla Variation II*).

Effingham I		Total (n = 103)	Laypersons (n = 36)	Artists (n = 43)	Art historians (n = 24)
N/A(Note 6)		*2*	*1*	*0*	*1*
	Copy	20	13	5	2
	Original	81	22	38	21

Hiraqla Variation II		Total (n = 103)	Laypersons (n = 36)	Artists (n = 43)	Art historians (n = 24)
N/A(Note 6)		*1*	*0*	*1*	*0*
	Copy	25	13	6	6
	Original	77	23	36	18

Table 3.

Number of participants (total and by groups) who noticed a difference between copy and original.

Effingham I	Total (n = 103)	Laypersons (n = 36)	Artists (n = 43)	Art historians (n = 24)

N/A (Note 6)	*0*	*0*	*0*	*0*
Did not mention a difference	27	16	9	2
Mentioned a difference	22	6	7	9
Noticed ‘copy’ and ‘original’	54	14	27	13

Hiraqla Variation II	Total (n = 103)	Laypersons (n = 36)	Artists (n = 43)	Art historians (n = 24)
N/A (Note 6)	*1*	*1*	*0*	*0*
Did not mention a difference	33	21	8	4
Mentioned a difference	40	7	20	13
Noticed ‘copy’ and ‘original’	29	7	15	7

Table 4.

Number of participants (n = 103) who mentioned, did not mention, or not specifically mentioned the ‘strongest colors’ in the original painting or in a printed copy of *Effingham I* and *Hiraqla Variation II*.

Frequency	No mention	Unspecific mention	Mention
Copy *Effingham I*	17	4	8
Original *Effingham I*	7	15	41

Frequency	No mention	Unspecific mention	Mention
Copy *Hiraqla Variation II*	0	0	0
Original *Hiraqla Variation II*	33	40	29

Table 5.

Number of participants (n = 103) who mentioned the presence of ‘fluorescent’ (‘fluo’) or ‘neon’ colors, ‘bright’ or ‘intense’ colors, or neither.

Frequency	Mentioned ‘fluo’ or ‘neon’ colors	Mentioned ‘bright’ or ‘intense’ colors	No mention

Copy *Hiraqla Variation II*	0	0	0
Original *Hiraqla Variation II*	27	43	32

Table 6.

Number of participants (n = 103) who experienced the paintings (*Tuxedo Park Junction*, *Effingham I*, and *Hiraqla Variation II*) 'instantly' or 'not instantly'.

Frequency	Not seen instantly	Seen instantly	*N/A (Note 6)*
Tuxedo Park Junction	51	26	*26*
Effingham I (original)	54	42	*7*
Hiraqla Variation II (original)	73	8	*22*