Comparative Analysis of Color and Outline in Andy Warhol's "Shot Marilyns" Series

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Abstract

This study examined the application of color and outlines in Andy Warhol's "Shot Marilyns" series from 1964. The aim was to systematically compare the colors used in the series, specifically focusing on the entirety, hair and lips, across five paintings (Light Blue, Sage Blue, Red, Orange, and Turquoise). Our initial hypothesis proposed the turquoise painting is closest to the sage blue in overall color. We also proposed a close color relationship between the hair in the Sage Blue and Orange paintings and identical lip color across all paintings. To test this, we resized the images and converted them into a dataframe for a detailed analysis using Hierarchical Clustering. This approach identified 15 representative colors for each painting and enabled the exploration of color distribution through three-dimensional plotting. We also mapped identified color clusters into a reference image and, focusing on the hair and lip colors, selected clusters from these areas and established the range of each RGB channel based on the centered values. These ranges were then used to identify the pixels within the given RGB range in the other four images. Our results revealed that the hair color in the Orange painting was indeed the closest to the Sage Blue. However, contrary to our initial assumption, the light blue painting was found to be closest to the sage blue in overall color, not the turquoise one. Also, the color of the lips was not consistent across all paintings; the Red painting exhibited a different lip color from the others. Our findings contribute to understanding Warhol's use of color in his iconic series and allow further analysis of his techniques and aesthetics.

I. INTRODUCTION

Andy Warhol, a prominent figure in the pop art movement, continues to captivate audiences with his vibrant and innovative art pieces. His distinctive use of colors and elements from popular culture has prompted a rich array of critical analyses and interpretations. Among his expansive repertoire, the "Shot Marilyns" series, created in 1964, stands out as one of his most significant artistic contributions. This series comprises multiple variations of the same screen-printed image of Marilyn Monroe, each variation defined by its unique color scheme.

In this study, we embark on a detailed analysis of color variations within the "Shot Marilyns" series. Our primary research goal is to compare the colors utilized in the entirety, hair and lips across five specific paintings: Light Blue, Sage Blue, Red, Orange, and Turquoise. Despite the visual differences, it is hypothesized that the Turquoise painting will show the most similarity to the Sage Blue painting in terms of the overall color scheme. Regarding the specific elements of the paintings, the Orange version's hair color is anticipated to align most closely with that of the Sage Blue version. Furthermore, we predict that the lip color will remain consistent across all versions. Guided by the hypothesis, we have devised a meticulous methodology.

Our methodology involves resizing the paintings and converted into a data frame to allow for comprehensive color analysis using Hierarchical Clustering. This method will enable us to identify

representative colors and explore color distributions in three dimensions mapping identified color clusters into a reference image, focusing primarily on the colors of the hair and lips. Further, based on centered values, we establish the ranges for each Red, Green, and Blue (RGB) channel. Using these ranges, we identify the pixels within the given RGB ranges for the four other images, allowing for precise comparison of color variations in Warhol's work. By isolating the hair and lip colors, we will examine these specific areas across the five versions for comparative purposes.

In the subsequent sections of this paper, we will provide a more in-depth look at our methods, discussing the strategies and procedures that led us to our findings. This study aims to contribute to understanding Warhol's unique color use and artistic style, particularly within the "Shot Marilyns" series. With this approach, our study aims to not only demystify Warhol's color selection in the "Shot Marilyn" series but also to contribute to broader discussions in art analysis and color theory. We believe our research will deepen the comprehension of Warhol's aesthetics, opening new avenues for future examinations of his impactful oeuvre.

II. METHODS

The primary goal of our study was to compare the colors used in the hair and lips across five variations of Warhol's "Shot Marilyns" paintings. based on a multi-step process using data manipulation and clustering techniques.

1. Selection of Images and Areas of Interest

We selected five versions of the "Shot Marilyns" paintings: Light Blue, Sage Blue, Red, Orange, and Turquoise. Our study focused on the entirety, hair and lips of the depicted Marilyn Monroe, regions that exhibit striking color contrasts and are defining characteristics of Warhol's style.

2. Image Preprocessing:

Firstly, the original images, each having a dimension of (1000, 1000, 3) denoting 1000 * 1000 pixels and 3 RGB channel values, will be resized to 512×512 pixels. After resizing, the images will be converted into a data frame format. Here, each image will be represented by 262144 rows (pixels) and 3 columns representing the Red, Green, and Blue (RGB) channels. This conversion allows the colors to be analyzed in a structured, numerical manner.

3. Color Quantization and Dimension Reduction:

A 101010 RGB cube will be used for each color representative. The cube will slide over each pixel of the images, identifying the median value of each RGB channel to establish a 'center color' for each cube. This process will reduce the color space from a possible 256^3 to a manageable 101010.

4. Hierarchical Clustering and Representative Colors:

Following the preprocessing, Hierarchical Clustering will be used to identify color clusters based on the RGB centers. We will specify 15 clusters for each image, and the average value for the R, G, and B channels within each cluster will be used as their representative color, leading to 15 representative colors for each image. Averages of all center values for each RGB channel will also be computed, forming an overall representative color for each image. For each color cluster identified in the reference image, we determined the range for each Red, Green, and Blue (RGB) channel based on their centered values.

5. Color Distribution Exploration:
Finally, the distribution of the 15 representative colors, as well as the overall representative color for each image, will be explored using 3D plots. This visualization will provide a vivid illustration of color composition and variations across the five paintings.

Focusing on Specific Elements:

6. Mapping Color Clusters
We first mapped identified color clusters using the Sage Blue version as a reference image. We specifically concentrated on the hair and lip colors. This clustering allowed us to define the critical colors used in each area of interest and establish a baseline for comparison with the other four paintings.

7. Identifying Corresponding Pixels in Other Images
With these RGB ranges established, we identified the pixels in the other four paintings (Light Blue, Red, Orange, and Turquoise) that fell within these ranges. The purpose was to compare the color clusters identified in the Sage Blue reference image with their corresponding pixels in the other versions.

8. Visual Representation
For enhanced clarity and to facilitate understanding, the identified pixels in each of the four images were displayed in purple. This color choice was intentional as purple was not present in the original images, thus ensuring our highlighted pixels would be distinct and easily identifiable.

9. Comparison and Analysis
Finally, we compared the identified color pixels across the five images, specifically focusing on the hair and lip regions. This comparison facilitated a nuanced understanding of the color use in each painting and helped us draw conclusions about Warhol's use of color in this series.

III. RESULTS AND DISCUSSION

Hypothesis 1: Comparison of Entirety Across Paintings

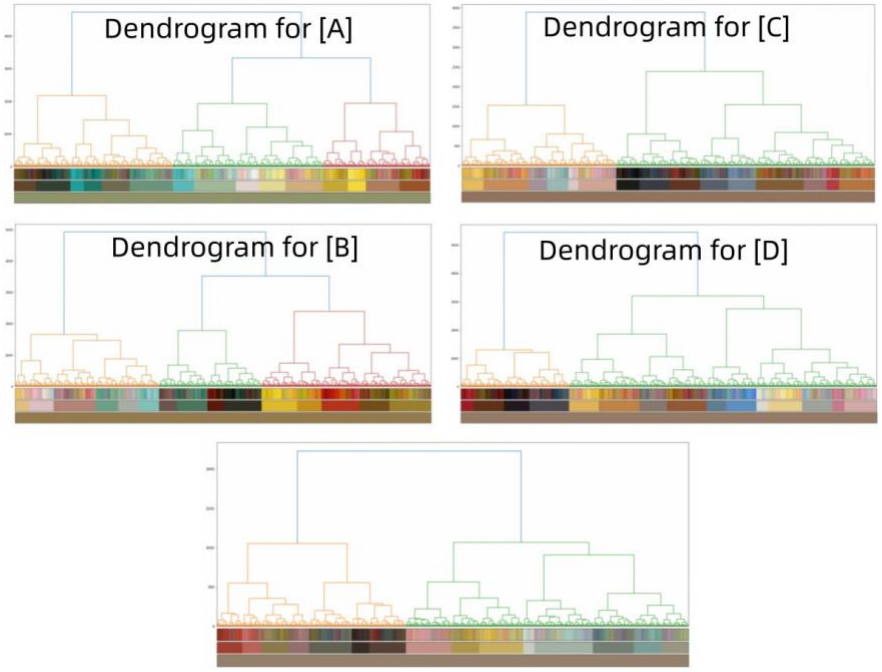
The first phase of our analysis entailed comprehensive preprocessing of five paintings in Andy Warhol's 'Shot Marilyn' series. The images, originally of dimensions (1000, 1000, 3), were resized to (512, 512), and then converted into a dataframe, resulting in 262144 rows representing the pixels and 15 columns for the RGB channel values.

In order to reduce the dimensionality due to the extensive range of each RGB channel (0-255), we engineered a color representative cube of dimensions 101010. This cube was used to scan over each pixel in the images. The RGB values for each pixel were then adjusted to represent the median for each axis. For instance, an original pixel value of (150, 69, 82) was reassigned to (145, 65, 85).

Following preprocessing, Hierarchical Clustering was utilized to identify color clusters, based on the calculated RGB centers. This led to the definition of 15 representative colors for each image, attained by averaging the R, G, and B channel values for each cluster. Further, we computed an overall representative color for each image, by averaging all center values for the R, G, and B channels.

Figure 1 depicts the dendrogram of the Unique Centers and Representative Colors (15 representatives via average of all RGBs in each cluster) for each painting in the series. The subsequent visualization of these unique centers offered an in-depth perspective into Warhol's use of color.

Figure 1



Dendrogram of the Unique Centers and Representative Colors

Figure 2

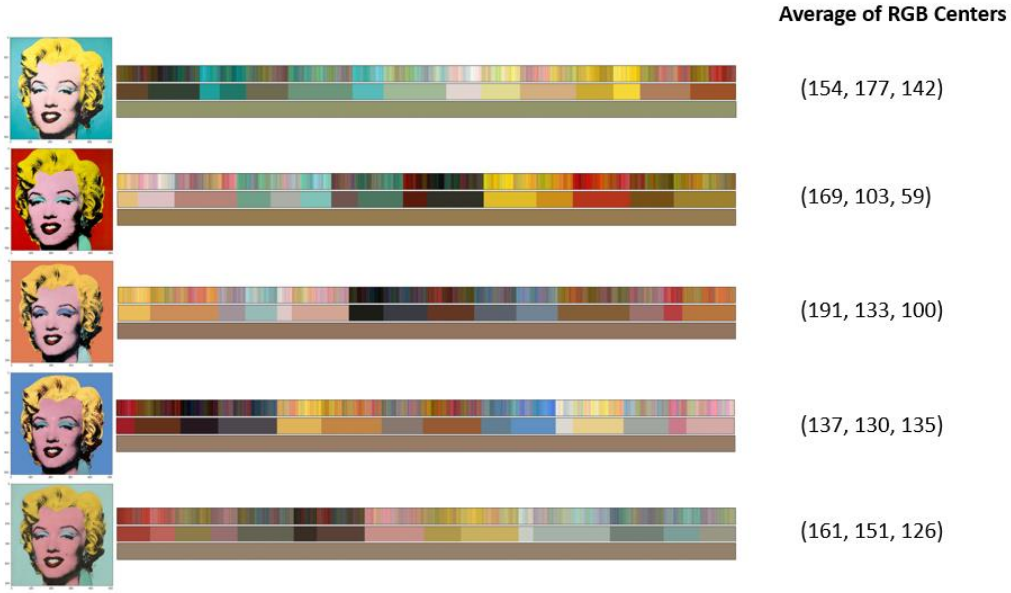


Figure 2 presents the average center values for the R, G, and B channels for each image and the distribution of the 15 cluster colors. This provided an illustrative depiction of the dominant hues and their distribution within each painting. The 3D plot in Figure 3, based on the averaged representative color for each image, further elucidates the relationship between the dominant colors of each painting.

The hypothesis, "In terms of the overall color, the turquoise [A] is the closest to the sage blue", was then put to test. We computed the Average of RGB Centers for all pictures within a three-dimensional system. Unexpectedly, these calculations, as shown in Figure 4, revealed that the light blue version [D] was closest to the sage blue [E] in terms of overall color, challenging our initial hypothesis.

Figure 3

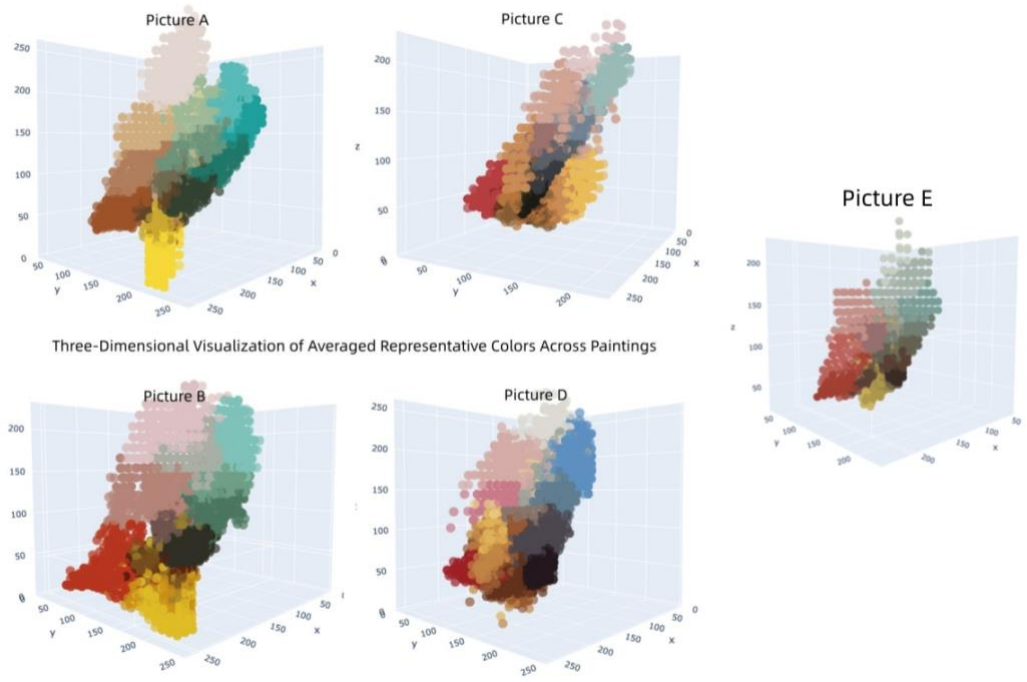
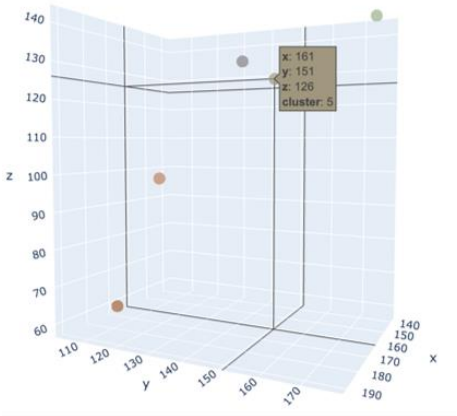


Figure 4



Hypothesis 2: Comparison of Hair Color Across Paintings

To validate our first hypothesis, which proposed a close similarity between the hair color in the Sage Blue (pic E) and Orange (pic C) paintings, we began mapping identified color clusters onto the reference image, pic E. We focused our attention on the hair color clusters, identifying them among the 15 distinct color clusters present in the image. These clusters were represented in purple for a clear differentiation from other color clusters.

For the hair color cluster of pic E, we obtained the range of each RGB channel based on centered values, allowing us to find corresponding color clusters in the other paintings. Displaying the identified pixels in purple for each of the other four paintings facilitated a visual comparison of hair colors across all five versions.

In pic E, the area covered by the hair color (represented in purple) accounted for a significant portion of the total area of the image, specifically, 48265 out of 262144 pixels, which amounts to 18.4% of the total area in Figure 5.

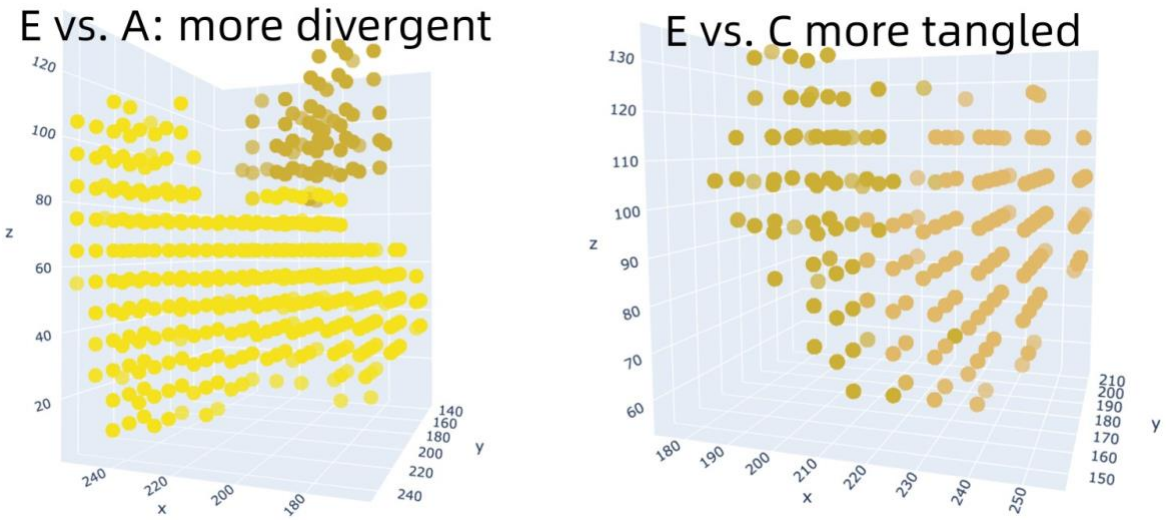
Figure 5

Figure 6

The other four images found the same color but to varying extents. As Figure 6 shows, in pic A (Light Blue), the same hair color covered 8097 out of 262144 pixels (3.1%); in pic B (Red), it covered 1275 out of 262144 pixels (0.5%); in pic C (Orange), it was 27658 out of 262144 pixels (10.6%); and in pic D (Turquoise), it was 17778 out of 262144 pixels (6.8%).

When comparing the overlap of the same hair color found in pics E and A (E vs. A) with that of pics E and C (E vs. C), the visual representation showed a higher degree of similarity between pics E and C, with more intertwined purple areas. In contrast, the E vs. A comparison exhibited greater divergence. These comparisons can be found in Figure 7.

Figure 7



These findings suggest that, as per our initial hypothesis, the hair color in the Orange painting (pic C) is indeed the closest to that in the Sage Blue painting (pic E). The E vs. C comparison data visualization offers compelling visual evidence of this close color similarity, making it more tangible and easier to grasp. The numerical data further supports this assertion, demonstrating that the same hair color covers a more significant percentage of the total area in pics E and C compared to the other versions.

Hypothesis 3: Comparison of Lip Color Across Paintings

We applied a similar methodology to the hair color analysis to test our second hypothesis, which suggested uniformity in the lip color across all the paintings. We mapped the identified lip color clusters in the reference image, pic E (Sage Blue), and represented these clusters in purple for more precise visualization. The range of each RGB channel for the identified lip color cluster was determined based on centered values. As Figure 8 shows, in pic E, the area of the lip color accounted for 878 out of 262144 pixels, which amounts to 0.3% of the total image area.

This same lip color was found in varying quantities in the other four images, shown in Figure 9. In pic A (Light Blue), it covered 611 out of 262144 pixels (0.2%); in pic B (Red), it was 280 out of 262144 pixels (0.1%); in pic C (Orange), it was 915 out of 262144 pixels (0.3%); and in pic D (Turquoise), it covered 1482 out of 262144 pixels (0.6%).

On comparing the distributions of the identified lip color in each painting, we observed a divergence contrary to our initial hypothesis. Specifically, pic B (Red) presented a significantly lower percentage of the reference lip color, suggesting a different lip color.

Figure 8

Figure 9

In summary, these results indicate that the lip color differs across all versions of Warhol's "Shot Marilyns" series, refuting our initial hypothesis. The Red version (pic B) notably exhibits a different lip color from the others, visually and numerically. Our study highlights the subtle yet significant color variations in Warhol's series, enhancing our understanding of his approach to color usage and its impact on the overall aesthetics of his works.