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Why Was the Color Violet Rarely Used by Artists before the 1860s?

A Descriptive Summary and Potential Explanation

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Abstract

Although the color violet is now used in a wide variety of everyday products, ranging from toys to clothing to cars, and although it now appears commonly in artistic works, violet was rarely used in fine art before the early 1860s. The color violet only became an integral part of modern culture and life with the rise of the French Impressionists. I investigated the use of violet in over 130,000 artworks prior to 1863 and found that it appeared in about .06 percent of the paintings. Violet was used substantially more frequently in Impressionist works, and remains popular in fine art and in popular culture today. I examine several explanations for the explosion of the use of violet in the art world during the Impressionist era, and conclude that a cognitive-perceptual explanation, based on the heightened sensitivity of the Impressionists to short wavelengths, may account for it. The findings fit with a new understanding about evolutionary changes in planetary light and human adaptation to light.

Keywords

violet color – visual perception – neuroscience – astrobiology – high-energy cosmic rays – evolution of visual cognition – culture – evolution

This paper examines a curious phenomenon: Until the time of the Impressionists in the mid-nineteenth century, works of art (though they contained color combinations and shades covering the rest of the spectrum) did not contain the color violet. After this time violet became much more popular and remains so today. There is no prior examination of this topic that I am aware of, and there are no other colors that I know of that experienced such a dramatic shift in usage in artwork over such a short period of time. The finding itself is interesting, and potential explanations for it relate broadly to principles of optics, neuroscience, biology, astrobiology, cognitive science, psychology, anthropology, linguistics, and culture.

The color violet itself must be differentiated from a closely-related color, purple, which has been used abundantly in fine art. Although the two colors may seem similar to many viewers, from the point of view of optics, there are important differences. Violet is a spectral color with its own set of wavelengths on the spectrum of visible light. Purple on the other hand is a polychromatic color, made by combining blue and red. Purple is reddish and belongs to the red family of colors, whereas violet is bluish and belongs to blue family of colors.

1 Method

Upon observation, one can easily see that some colors, such as purple, have been commonly used in fine art for centuries, and see that violet is used prolifically in contemporary art. But because violet was much less commonly used prior to the early 1860s, a large sample of art must be collected in order to validly assess its prevalence.

The true colors of artwork, and especially the color violet, cannot be reproduced with perfect accuracy on paper or a computer monitor, and thus I visited numerous museums worldwide in person to assess its prevalence.

I analyzed each piece of art individually, making judgements about its use of color using the Munsell Color Book (1961) which I consulted as I inspected each work, helping minimize errors introduced by changes in lighting or dependence on color memory. If the painting contained violet I coded it as such. Otherwise, I coded the painting as not containing violet.

Here are the color coordinates from the Munsell Color Book that I used to identify violet color in art works:

2.5P 2/6; 2.5P 3/6–3/8;
5PB 8/4;
7.5PB 1/0–1/16; 7.5PB 2/16;
10PB 1/8–1/10; 10/PB 2/10–2/14; 10PB 3/10–3/16; 10PB 4/12–4/16;
10PB 5/14–5/16; 10PB 6/12–6/14; 10PB 7/10; 10PB 8/8

In total I analyzed 139,892 works of art. The work came from 193 museums in 42 countries. It should be noted that I did not generally have permission to study museum archives. Though I cannot rule out the possibility that these collections contained works with violet, there is no reason to think the percentage of such works would have been different in these collections than in those I was permitted to study.

My sample included Eastern and Western cultures from Paleolithic to the mid-1900s and included architecture, sculpture, paintings, graphics, folk arts and crafts as well as the fields related to art history, such as anthropology and archaeology. The research included data from Prehistoric art (including Paleolithic, Mesolithic and Neolithic periods), Metal Age, Ancient Mediterranean and Mesopotamian art, Egyptian art, Greek and Etruscan art, The Maya, Inca, and Aztec art, Roman art, African art, art of Oceania, Medieval art, Asian art, Renaissance, Mannerism, Baroque, Rococo, Neoclassicism, Romanticism, Academic art, Impressionism, Post-Impressionism, and Modern art.

As a comparison, I also coded the prevalence of the color purple in paintings prior to 1863 by coding 418 paintings currently on display in the West Wing of the National Gallery in Washington DC. I also coded the prevalence of the color violet in paintings since 1863 by coding 329 paintings of Impressionists, Post-Impressionism, and Modern art currently on display in the West and East Wings of the National Gallery in Washington DC.

2 Results

Out of the total of 139,892 works of art that I coded, I found only eighty-seven works with true violet color. In other words, violet was used in only about .06 percent of the works that I examined — violet was almost nonexistent in paintings before the mid-nineteenth century.

I did another analysis on a subset of the total paintings — the works of artists from different regions of the world with the images of flowers. Comparing 290 paintings and illustrations created by European, Chinese, Indian, Persian and Japanese artists of the seventeenth century, I was able to confirm the widespread absence of violet flowers and vegetation in this period of time. The works of two Flemish artists, Jan Brueghel the Elder (1568–1625) and Jan Brueghel the Younger, (1601–1678) who specialized in painting flowers, were the part of this sample.

Here is the list of art works made before the mid-19th century that contain true violet color.

1. Bernardo Daddi, Saint Paul, 1333. National Gallery, Washington DC, USA
2. Khuhraw Comes to Shirin's Castle, Iran, Tabriz, late 14th century. Freer/Sackler Gallery of Art, Washington DC, USA
3. Andrea di Bartolo, The Nativity of the Virgin, 1400/1405. National Gallery, Washington DC, USA

4. Rogier van dear Weyden, The Descent from the Cross, 1435. Prado, Madrid, Spain
5. Rustam Shoots His Half-brother Shaghad through a Pane Tree, 1482 Folio from the Shahnama (Book of Kings) of Firdausi, Iran, Shiraz, Timurid period, Metropolitan museum, New York, USA
6. Benvenito di Giovanny, The Crucifixion, 1491, National Gallery, Washington DC, USA
7. Shaikh Zada, Interior Reception, ca. 1525–35. probably Bukhara, Safavid period, Metropolitan museum, New York, USA
8. El Greco, The Disrobing of Christ. 1577–79, Cathedral of Toledo, Spain
9. El Greco, The Miracle of Christ Healing the Blind. ca. 1570. Metropolitan museum, New York, USA
10. The Simple Peasant Entreats the Salesman Not to Sell His Donkey. Iran, Safavid period. 1556–1665. Freer/Sackler Gallery of Art, Washington DC, USA
11. The Old Man Chides a Foolish Youth. Iran, Safavid period, 1556–1665. Freer/Sackler Gallery of Art, Washington DC, USA
12. Anthony van Dyck, Portrait of a Woman and Child, about 1620–21. National Gallery, London, UK
13. Fyodor Rokotov (after Roslin), Catherine II, 1780s. Hermitage, Saint Petersburg, Russia

In addition to the thirteen art works listed above I also found violet in another seventy-four artworks in Islamic art (mostly Persian miniatures) and Indian art (mostly Mughal miniatures).

On the other hand, purple was used freely before 1863, being observed in 101 of the 418 paintings I coded in the West Wing of the National Gallery (24%). And violet continues to be used frequently in modern art. I found violet in 20 of the 329 paintings since 1863 that I coded in the West and East Wings of the National Gallery (6%).

3 Explanation

I see three possible explanations for the absence of violet in works of art before the mid-nineteenth century. The first such explanation is that violet pigments were not used in painting because, although painters were able to perceive violet, and wanted to paint the violet color, the pigments were not available or were prohibitively expensive. Analysis of colors used by painters prior to the mid-19th century suggests that the violet pigment was available by mixing red and blue colors, but at the same time the natural violet dye was expensive

(Laurie, 1929; Berke, 2007; Ziderman, 2009; Verhecken & Pikhaus, 2012). Yet, for such famous and wealthy artists as Titian, El Greco, Raphael, Michelangelo, Leonardo da Vinci, Anthony van Dyck, and Peter Paul Rubens, a high price was no obstacle. If these artists had wanted to use violet in their paintings, given the pigment was available, they could and would have done so. It does not seem likely, then, that the lack of or cost of pigment is a plausible explanation.

The second explanation is based on potential changes of flora and fauna (and in other aspects of the environment) during the planet's history. We might suppose that, until recently, commonly known flowers such as purple lavender, purple lilac or purple and blue pansies were widely spread in nature but possibly lacked the violet shades of which they are known today, at least not in Europe, where some of the artworks included in my research were painted. We could then surmise that artists did not use violet in their work because they did not see examples of the color violet in nature. The absence of violet flowers in the paintings of old masters, such as in Dutch still-life paintings showing numerous colorful flowers, could be taken to support this hypothesis.

Support for this explanation would be bolstered if we also found the lack of violet color in botanical works from before the mid-nineteenth century. Although botany began to exist as a scientific field in the seventeenth and eighteenth centuries, so that it could ostensibly tell us about the presence or absence of violet in nature beginning in the seventeenth century, the information in botany texts from before the mid-nineteenth century is too limited to be of much use. The information contained in botanical manuscripts from this early period provides information about only a limited, and probably quite unrepresentative, sampling of plant life that happened to be of interest to the first botanists. As for the earlier periods, Antiquity and the Middle Ages, the plant-life-related works that a few authors created during those times provide far too little information to give us a complete picture of the common vegetation then found in nature.

We do know, however, that flora changes colors and form over time. Hodges and Derieg (2009) documented the evolution of columbine flowers in North America arguing that a color shift from red to white or yellow has happened five times in North America. "Ultimately we want to know if evolution can be predictable … In other words, we want to know if each time there is an evolutionary change in flower color, does it happen in the same way?" said these authors.

In sum, because flowers do change color over time, the possibility that the color violet appeared in the world's flora in the 19th century should not be discounted. Perhaps the violet lavender, lilac and pansies became widely spread in nature at the time of the Impressionists and this attracted special attention from this highly sensitive to short wavelength group of painters. The Impressionists used the color violet so prolifically that critics accused the painters of having "violettomania" (Reutersvärd, 1950). The terminology represents one of the most notable signatures of the Impressionists' color vision.

The manner in which the Impressionist painters related to their world, including its colors, made them particularly able to sense new experiences. The impressionists were likely particularly high on the "Openness to experience" sub-scale of the "Big Five" personality traits is associated with having more "cognitive reserve". It correlates with divergent thinking skills and with being more intuitive and creative. Openness correlates with, but is distinct from, intelligence. Psychologists continue to study the basis of "Openness" at a cognitive and neural level. Antinori and colleagues (2017) argued that this trait is central to human nature and that individuals reporting greater openness to experience may also have characteristically different low level perceptual experiences. It seems "open" people "see" the world differently.

A third explanation is a physiological-cognitive-psychological one, based on adaptive changes in human color vision over evolutionary time and the expansion of the brain's capabilities of perceiving color. It is possible that the lack of violet in art before the mid-nineteenth century resulted from a relative lack of sensitivity to violet in the visual cones responsible for short-wavelength light (The Blue cones or S-cones) in humans prior to the Impressionist era. In short, this hypothesis proposes that humankind's increasing level of color sensitivity played an important role in the burst of violet paintings in the 19th century.

It is known that color perception in humans has become more complex over evolutionary time. Yokoyama and colleagues (2014) studied the evolutionary pathways of human vision, providing a timeline for the development of color vision. This study traced the evolutionary pathways that led to human vision, going back 90 million years. The authors summarized: "Phylogenetic analysis … suggests that the blue-sensitivity [of human vision] was achieved only gradually. During the period between 45 and 30 [million years] ago, human [visual pigment] S1 was in the final stage of developing its blue-sensitivity. This was the time when two red-sensitive pigments appeared by gene duplication and one of them became green-sensitive. Trichromatic color vision in the human lineage was fully developed by 30 million years ago by interprotein epistasis among the three visual pigments" (p. 2). Their analysis suggests that the blue sensitivity of human vision was the last to develop (after red and green). Indeed, only about 2% of the cones in the human eye are blue (type S) cones.

Why would this change in color perception happen so late in human development? Biologists say that sponges are the most primitive multicellular animals. They have two genes, Pax and Six, that are involved in the eye development of most animals. Although the functions of the sponges' genes are not the same as they are in more developed species, these genes interact with one another in similar ways in both simple and more complex organisms. The genetic mechanisms for the development of eyes arose earlier in the course of evolution than the eyes themselves (Rivera, Winters, Rued, Ding, Posfai, Cieniewicz et al., 2013). Another research team sought to identify the hidden mechanisms underlying the evolution of the nervous system (Parker, Bronner & Krumlauf, 2014). They concluded that the brains of vertebrates were formed according to genetic "blueprints" created in advance. Again, the genetic blueprints for constructing more complex and capable nervous systems existed well before their physical manifestation in evolution. Only much later, after organisms had developed to the level in which the blueprints could begin to be imposed, did the physical changes made possible by them occur (Erwin, Laflamme, Tweedt, Sperling, Pisani, Peterson et al., 2011). Advance genetic blueprints may have played a similar role in the evolution of human nervous systems, including our eyes' sensory capacities and our brain's perceptual abilities.

Human visual sensitivity has evolved from early sensitivity only to the (long wavelength) red range of the visual light spectrum, to later sensitivity to the (middle wavelength) green range, and eventually to sensitivity to the (short wavelength) blue-to-violet. As human trichromatic vision gradually developed, growing numbers of humans acquired sensitivity first to some blues, then to the full range of blues, and presumably, finally to some and then to all violets.

The lack of sensitivity in the blue range of the spectrum is also found in perception of the color indigo. Since the first recorded use of "indigo" as an English color name in 1289 (Maerz & Paul, 1930), more than 700 years have passed. But even now the human eye is relatively insensitive to indigo's wavelengths, and some otherwise well-sighted people cannot distinguish indigo from dark blue (Evans, 1974; Waldman, 2002; McLaren, 2007). As violet color belongs to the blue family of the visible-color spectrum (that is, the family of short-wavelength colors sensed by the blue or S-cones), the same evolutionary principle applies to violet.

This progression in which blue is the last color to be learned was also noted in a study of Lazarus Geiger (1878, 1880), who found that in ancient texts from all over the world, including the Bible, Vedic hymns, and Icelandic Sagas, color names appeared sequentially, following the order that the colors appear on the spectrum (with blue last). Geiger also noticed that languages developed the words for colors in the same distinct order, with blue always being the last to emerge, and posited that this must have an anatomical basis in the evolution of visual perception. Geiger believed that people gradually became aware of color over time and that this awareness was connected to the order of colors in the spectrum, moving from the longest wavelengths (red) to the shortest (blue). Berlin and Kay (1969) confirmed Geiger's hypothesis and showed a universal regularity underlying the apparently arbitrary way language is used to describe the world. Since then, the color hierarchy (black/white, red, yellow/green, blue) has remained generally accepted.

The triple structure of vision from monochromatic through dichromatic to trichromatic as well as the discovery of Yokoyama's team testifies that such an evolution of vision from simple to more complex occupied a huge evolutionary period and should be caused by specific reasons. Since color vision is a reaction of retina's receptors to different wavelengths, it can be assumed that the global change in the activity of light on the planet (from a long wavelength to a medium and short wavelength) at different periods of its evolution could lead to an evolution in mankind's color vision.

This is in agreement with Geiger's (1878, 1880) model, Berlin and Kay's (1969) research, Davidoff's (1999) and Gibson's (2017) studies, as well as Yokoyama's (2014) findings. This helps to understand the causes of coloration change of the planet's vegetation and explains the reasons for the appearance of shades of violet in flowers known to mankind for a long time as a lavender, lilac or pansy. This also explains the changes in cognitive responses of mankind to the occurring global changes in nature, since the presence of more developed forms of color vision gives an opportunity in the development of all forms of culture, including the fine arts.

The evolution of mankind depends on many factors of the external environment (Brodin, Jojic, Gao, Bhattacharya, Angel, Furman et al., 2014) such as the change of the activity of the planetary light. Light influences the human brain's cognitive functions by conveying a strong stimulating signal, and acts as a regulator for multiple neuroendocrine and neurobehavioral functions (Vandewalle, Maquet & Dijk, 2009; Vandewalle, Schwartz, Grandjean, Wuillaume, Balteau, Degueldr, et al., 2010; Chellappa, Gordijn & Cajochen, 2011). In this context, several models explaining evolutionary changes in planetary light and human adaptation to light are of interest.

Andrew Parker's "Light Switch" theory (1998) proposes that when atmospheric changes during the Cambrian increased the amount of light reaching the Earth, the evolutionary benefits of vision were increased and the eyes rapidly developed. Moreover, several research groups (Atri, Melott & Thomas, 2010; Melott, Thomas, Laird, Neuenswander & Atri, 2016; Melott, Thomas, Kachelriess, Semikoz & Overholt, 2017) provided new evidence of the impact of high-energy cosmic rays (HECRS) on the planetary atmosphere, biological planetary life, and human evolution, which complements Parker's theory. Evolution could have been potentially influenced by the occurrence of many supernovae near enough to Earth. This was confirmed by Melott's team by making the detailed measurements of radioisotopes in deep-sea deposits, and modeling of how they reached the Earth. Melott and colleagues found that high-energy cosmic rays would have caused a serious effect as atmospheric ionization (that makes a pathway for lightning to get started and causes a big increase in lightning) and appearance of blue light in the night sky.

Parker's theory is interesting, but I argue that a single macro-cosmic event can be the only cause for dramatic changes of the entire planetary ecosystem. I believe in Melott's model that local planetary changes should reflect global macro-cosmic events and they should also reflect the influence of such a powerful energy stream as high-energy cosmic rays. I also believe that there are a set of macro-cosmic events shaping the evolution of the planetary light.

4 Conclusion

At this point, an explanation can be proposed for why, until the Impressionists in the mid-nineteenth century, only a small percentage of painters used violet color in their paintings. We may surmise that these exceptional painters began to use violet color because, due to their heightened sensitivity (physically in their eyes as well as cognitively in their minds), they were the first to react to this newly prevalent wavelength of light. Only with the rise of French Impressionists in the nineteen century, who could not ignore the presence of violet in nature, did violet begin to emerge among other colors and eventually enter all spheres of life. This process took more than a century and only in our day has it reached its full strength. The Impressionists, as members of a society with a heightened sensitivity to short wavelengths, were the first group who (in contrast to some single artists preceding their appearance) perceived the color violet in their surroundings. Then, by using it in their works of art, they brought the color to the general public, such that now violet is a substantial part of our everyday color lives.

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