

**Color Culture and Science**  
**Cultura e Scienza del Colore**



**CCSJ**  
Volume 13  
Number 2  
2021

ISSN  
2384-9568

**COLOR CULTURE AND SCIENCE Journal**  
**CULTURA E SCIENZA DEL COLORE**  
**CCSJ**

jcolore.gruppodelcolore.it

ISSN 2384-9568

DOI: 10.23738/CCSJ.00

ANCE: E227716

Registrazione Tribunale di Milano n. 233: 24/06/2014

ANVUR Agenzia Nazionale Valutazione sistema Universitario e Ricerca

APeJ Academic Publications eJournal

BASE Bielefeld Academic Search Engine

DBH Database for statistikk om høyere utdanning

DOAJ Directory of Open Access Journals

EZB Elektronische Zeitschriftenbibliothek Regensburg

JURN Search tool for open access content

ROAD Directory of Open Access scholarly Resources

Volume 13, number 2, November 2021

DOI 10.23738/CCSJ.130200

**PUBLISHER**

Gruppo del Colore – Associazione Italiana Colore

www.gruppodelcolore.org

Registered office: Piazza Carlo Caneva, 4 - 20154 Milan (IT)

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- Relevance to journal's aims and scope
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11. Color and Education. Pedagogy, didactics of color, aesthetic education, artistic education.
12. Color and Communication/Marketing. Graphics, communication, packaging, lettering, exposure, advertising.

# Table of Contents

Editorial	5
<i>Maurizio Rossi</i>	
Zhang Ymou: great master of color	7
<i>Lia Luzzatto, Laura del Zoppo</i>	
DOI: 10.23738/CCSJ.130201	
A didactics of colour based on an innovative educational approach at the Hochschule für Gestaltung in Ulm	13
<i>Annamaria Poli</i>	
DOI: 10.23738/CCSJ.130202	
Color and materials in design didactics. Design of a playroom and relaxation area for children – case study	27
<i>Anna Kmita</i>	
DOI: 10.23738/CCSJ.130203	
Visual grouping: a study on preponderances of color or shape in Match-three games	34
<i>Joyce C. Cavallini, Paula Csillag</i>	
DOI: 10.23738/CCSJ.130204	
Is white skin really pink? Flesh color as a pink color in Western art and culture	42
<i>Kévin Bideaux</i>	
DOI: 10.23738/CCSJ.130205	
Geometric models for color perception	50
<i>Nicoletta Prencipe, Edoardo Provenzi</i>	
DOI: 10.23738/CCSJ.130206b	
The red of Lina and Oscar	57
<i>Luiza Paes de Barros Camara de Lucia Betlramini, Paulo César Castral</i>	
DOI: 10.23738/CCSJ.130207b	

The Changes of Transparent Colours in Being Laid upon Others': Considerations for a New Perception of Glazes with Historical Pigments and Dyes 64

*Miquel Herrero-Cortell, Paola Artoni, Marcello Picollo, Marta Raich, Maria Antonia Zalbidea*

DOI: 10.23738/CCSJ.130208b

A test on color discrimination in complex scenes for a better comprehension of color blindness 72

*S. Scipioni, C.A. Lombardi, L. Giuliani, A. Mazzoni, R. Marcucci, A. Plutino, A. Rizzi*

DOI: 10.23738/CCSJ.130209b

Umbrella Diagram: 1981-2021, five decades of forecasts and CMF design 84

*Clinio Trini Castelli*

DOI: 10.23738/CCSJ.130210b

# The Changes of Transparent Colours in Being Laid upon Others': Considerations for a New Perception of Glazes with Historical Pigments and Dyes

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## ABSTRACT

This article describes a reconstruction of 40 sequences of historical glazes used by most European schools of painters from the 15th to the 18th century. Its main objective is to visually document the appearance of colours overlaid with historical pigments and dyes, which have often suffered from a degree of deterioration that renders it difficult to determine their original appearance. We also seek to show the extent to which the historical glazes and overlays can alter our perception of the underlying colour. To this end, lab tests and sources have been used with the aim of suggesting a series of sequences of colour overlays that were widely used in the aforementioned period, so as to reproduce them on a canvas using historical pigments and colours agglutinated in oil, in accordance with the main painting techniques of the era studied.

**KEYWORDS** historical pigments; dyes; glazes; colour overlays

**RECEIVED** 14/08/2021; **REVISED** 19/10/2021; **ACCEPTED** 27/10/2021

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## 1. Introduction

Until the 16th century, artists followed the Flemish style of producing paintings with a finely glazed appearance, excellent for painting on panels, with several very thin layers of colour interacting with each other, and very rarely using monochrome finishes comprised of a single layer of paint. This approach suggests the need for a different view of the history of oil painting techniques, whose base problem should be considered not in terms of invention or individual discovery (as Giorgio Vasari has accustomed us to think) but in relation to a long evolutionary process that is documented in the treatise attributed to Theophilus Presbyter (Del Vescovo, 2013: 244-255). Painting technique remained unchanged even when painters began turning to canvas as a support medium, and it was only between the late 16th and early 17th century that European paintings acquired a more full-bodied appearance. However, glazes continued to be widely used as a technical solution right through to the 19th century, when new trends fuelled the quest for different visual effects, created with thicker brush-strokes. This development was related to the development of industrial colours, much thicker and more opaque, which also dried more quickly and offered a wider palette of colours. Glazes began to lose their practical purpose because colour modulation was no longer such a popular technique and although it has continued to be used up to the present day, its application in the 19th century was in fact uncommon. The term 'glazing' appeared for the first time in the treatise *On the True Precepts of the Art of Painting* by Giovanni Battista Armenini (1587), although, as will be discussed below, the concept dates back further.

Other authors, such as Francisco Pacheco and Antonio Palomino, referred to this practice as '*baños*' ('bathing'). It is not easy to define exactly what a glaze is: the term designates any translucent or transparent layer of colour placed over a lower layer with the intention of changing the underlying colour, or of giving it a new hue, in order to darken, brighten, or intensify the saturation or to form a compound colour. Until the 19th century, the relatively limited nature of the palette necessitated the use of effects of chromatic transparency that could produce more complex tones than those offered by pigments used individually. In reality, rather than glazes, it was common practice to use colour overlays. It is important to remember that the painting technique of overlaying colours was a practice typical of the panel painting of the late Gothic period, as documented in Chapter LXXXIX of Cennini's *Il Libro dell'Arte*. That same chapter also contains an interesting passage about the process of painting in oil being too slow and dull, a point made previously by Theophilus. In Chapter XXV of *De diversis*

*artibus* (Hawthorne, J. et al. 1979, [s. XII]) he provides instructions on this painting method '[...] whenever you have laid on the pigment, you cannot lay a second over in until the first has dried out. This process is an excessively long and tedious one in the case of figures [...]]' [1], which is expanded on in the following chapters up to Chapter XXVII, where he describes the process of 'translucent' painting.

Three centuries later, Leonardo da Vinci (1817 [s. XVI]) [2], in Chapter CCL of his *A Treatise on Painting*, would discuss the phenomenon of colour overlay, or '[...] the changes of transparent colours in being laid upon others of different kind [...]', which inspired the title of this article.

Most of the pigments available on the palette from the 15th to the 18th century were translucent to a certain extent, especially when applied thinly, and more translucent still are dyes, which become lake pigments when they are precipitated on an inorganic substrate such as rock alum, calcium carbonate or sodium carbonate. The use of lake pigments applied over pigments was much more common than is generally believed; moreover, it was essential to the development of a whole range of tones that made it possible to blur the colour and expand the chromatic possibilities (Thompson, 1956; Bruquetas, 2003; Herrero-Cortell, 2019).

## 2. Materials and Methods

The main purpose of this article is to reconstruct some of the main sequences of glazes made from pigments and lake pigments, as practised by Europe's main schools of painting from the 15th to the 18th century, based on paint stratigraphies (which are not included here due to space limitations) and historical sources. Due to the relatively rapid degradation of many of these materials, the appearance of the colour can change dramatically over time: the yellowing of oils and darkening of varnishes that tend to occur with these mixtures, as well as other factors like the degradation of dyes and pigments, low stability to light and other environmental parameters, mean that the colours rarely look as they originally did (Zalbidea, 2014: 33-37). For example, there are well-known cases of colour instability that have been found in works by painters like Lorenzo Monaco (ca. 1407), such as the *Coronation of the Virgin*, preserved at the National Gallery in London, the *Coronation of the Virgin* at the Uffizi Gallery of Florence, and the *Coronation* at the Courtauld in London (Burnstock, 1988).

This article has three specific objectives:

1. To reconstruct a palette of colours with glazes that cannot be observed today due to the effect of the

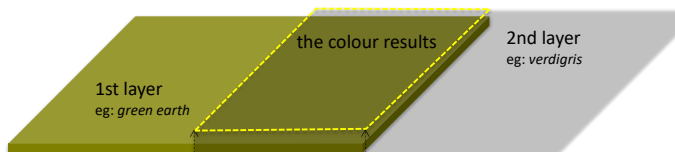
degradation factors mentioned above. This reconstruction has involved the use of historical pigments and dyes that are largely obsolete today.

2. To highlight how glazes or overlays of these translucent materials are able to alter the viewer's perception of the underlying colours.

3. To provide a set of standards for future spectroscopic and multi-band imaging studies in the form of the test strips processed for this study.

The performance of this study required the application of 40 sequences documented in written sources and stratigraphies. Most of the pigments used to produce the test strips were provided by the company Kremer, although some pigments, such as saffron, reseda and kermes, have been developed using traditional recipes, fixing the dye with rock alum in cases that so required. The pigments used were: smalt (10000); azurite (10204); natural ultramarine, from lapis lazuli (10510); indigo (36007); vermilion (42000); minium (42500); English red deep (40545); laccifer lacca carmine (lac dye) (36020); rose madder; cochineal; Italian gold ochre (40220); orpiment (10800); Naples yellow, based on lead antimony (10130); reseda lake, prepared by hand according to traditional recipes; saffron lake; green earth (40810); natural malachite (10300); verdigris (44450); and sap green (37391).

Although it is a short list, the choice of products was based on their importance and distribution, which is why some materials used only in very specific locations and periods, such as orchilla, have been omitted.



*Fig. 1. The colours were arranged according to the diagram. The colour results interacting with the colour from the two layers. Eg: A second layer of verdigris was applied over a first layer of green earth.*

Various overlays of glazed colours were applied, ordered by hue: blue, yellow, red, green, a second green obtained by mixing yellow and blue, purple colours obtained by mixing red and blue pigments. Both the pigments and the lakes were agglutinated in linseed oil, ground with a porphyry stone and applied to the test strip so that the base colour, the colour of the glaze and the colour resulting from the overlay could all be viewed individually and simultaneously (Fig. 1). The support medium was a linen cloth prepared first with natural glue (as a “primer

coating”), followed by four additional layers of primer comprised of glue and calcium sulphate hemihydrate. The test strips were photographed with a Nikon D800 camera and colour card, with colour and white balance correction using an AIC card.

### 3. Results and discussion

#### 3.1. Blue

The traditional blue pigments are not very opaque and were often used for glazes. In tempera painting it was common to apply them with glue over a layer of red earth, as documented and confirmed by stratigraphic studies of mural painting up to the 15th century in both Italy and Spain. Painters often worked to create glazes with these blues, a practice that Pacheco adamantly condemned, except when the overlays were made with ultramarine: ‘I do not endorse bathed blues, unless made with ultramarine’ [3] (Pacheco, 1649: 392). Years later, Antonio Palomino would specify that ultramarine blue: ‘is used in two ways; either bathed or fashioned out of any of the other blues already made’ [4] (Palomino, 1947 [1715]: 501).

Smalt is a colour preferably used *al fresco*, but due to the sensitivity of its tone and its characteristic transparency as a result of its vitreous nature it was greatly valued for making glazes in oil as it has a more vivid tone than azurite. Tempering was also done with oil and varnish (Price, 2017: 135-154), although their blackening or yellowing tendencies were well known, due to effects derived from crushing the particles and because their index of refraction is very similar to that of oil used as a binding agent (Döerner, 1998: 69).

The use of smalt blue over azurite (Fig. 2. Sample 1) was common in the 16th and 17th centuries, although its introduction to the colour palette is identified by Bensi (1980: 33-47) as being around 1470-80. Its presence in layers has been documented in the Veneto region, and also among some Spanish baroque painters. The choice of two inorganic blues on a palette is certainly not commonplace, but as smalt is more vivid than azurite and even more transparent, it was sometimes used to give the blue a more saturated tone. For example, in his treatise Pacheco (1649) attests to the use of these two pigments together, although not as glazes.

It was much more common for azurite to be covered by ultramarine lapis lazuli (Fig. 2, sample 2). In fact, as it was slightly opaque and particularly expensive, ultramarine was reserved for the final layer of glaze. This is how the Portuguese painter Felipe Nuñez explains it in his treatise of 1615.



It was clearly a widespread practice to apply lapis lazuli over azurite or another blue, as can be found in numerous stratigraphies showing one or more azurite or even smalt layers under the ultramarine layer, and it is also recommended in Théodore Turquet de Mayerne's treatise in 1620 (Fels, D. 2010: 141).

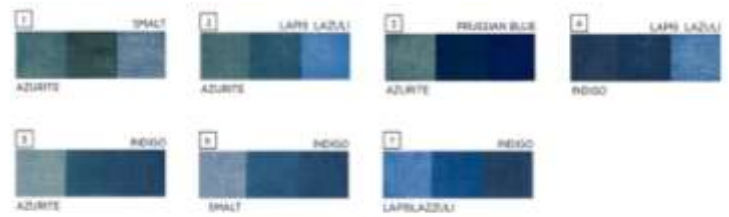
Prussian blue on top of azurite (Fig. 2, sample 3) was similarly used, but this blend was much less common and was largely limited to the 18th century. Prussian blue is dark by nature and it was therefore used to give greater depth to the azurite, especially when the latter was less pure or more greyish, or for the purpose of shading.

Indigo is a dye that was used widely in painting from the 14th through to the 19th century, although it has not received the attention it deserves. It was an economical solution when more expensive blue pigments could not be obtained (Herrero-Cortell, 2019: 13-15). Indigo of European origin was known as woad (even it was not pure woad, but a mixture [*guado puro o misto a travertino*], according to Brunello, 1975: 194) and the Asian dye was known as woad indigo. In both cases, its main dye is the same and its colour was identified with the term '*indigo*'. Its use added to other blue pigments to enhance them was documented by Eraclius in *De coloribus et artibus Romanorum*: [...] *Shade azure with indigo, lay on the lights with white lead* [...] (Merryfield, 1967: 257) [5].

Both lapis lazuli over indigo (Fig. 2, sample 4) and indigo over lapis lazuli (Fig. 2, sample 7) are used in shaded areas, for example in the folds of clothes. Lapis lazuli with black changes to dark grey, and the only way to give it depth and sheen without making it opaque is to add woad or indigo. This combination, which was already commonplace in medieval painting, continued to be used until the 16th century.

In his treatise, Palomino explains how the blue movement needed to be darkened with woad (indigo): '[...] *having to be fashioned, its tints of clear, and dark, can be blended in, mixing in proportion with the lead white in walnut oil, and enhancing the strong darks with the indigo.*' [6] (Palomino, 1947 [1715]: 501).

Even Pacheco mentions this custom, although with reference to azurite (Fig. 2, sample 5). Like indigo used with smalt to add shade to the vibrant tone of this blue (Fig. 2, sample 6), a very common solution in the 16th century in the painting schools of Spain and Northern Italy, such as the Venetian school, was to use both smalt and indigo to create these finishes. Indeed, the Padua manuscript (written in Venice around 1580) reads: '[...] *Blue azure with indigo, lay on the lights with white lead* [...]' [7] (Merryfield, 1967: 657).



*Fig. 2. Blue samples. 1) Smalt over azurite; 2) Lapis lazuli over azurite; 3; Prussian blue over azurite; 4) Lapis lazuli over indigo; 5) Indigo over azurite; 6) Indigo over smalt; 7) Indigo over lapis lazuli*

### 3.2. Yellow

The use of lake pigments and inks for yellow glazes was a very common practice in painting and is mentioned constantly in the treatises. In very rare cases stratigraphy reveals that yellows were made with pigments, given their high covering power. Yellow lakes (saffron, reseda and sap green) suffer considerably from deterioration and are highly unstable to light, making them difficult to recognise. For this study we chose to use lead antimony (commonly known as Naples yellow), which was often included on the palettes of 16th-century painters, lacking the option to use lead-tin yellow (*giollorino* or *giallolino zaldolino*, as it was known in Italy, while in France it was known as *massicot*; it is often confused with Naples yellow or antimony yellow), which was used as a base colour until the 17th century.

Saffron is one of the dyes most frequently found in recipes, associated with the colour change in the crushing and mixing stage, although it could be applied in glaze form to deepen or saturate the tone of other yellows on a lower layer (Fig. 3, samples 8, 10, 12), like reseda (Fig. 3, samples 9, 11, 13). Both saffron and ochre are mentioned in the late-14th century by Cennini, who, with respect to saffron, observed: *Do not expose it to the open air, for it soon loses its color* [...] (Ch. XLIX) [8]; however, it is a direct dye (that does not need a mordant) that was used frequently, as Palomino attested.

With respect to reseda (known in Spanish as *ancorca*), Palomino observes: '*Greenish-yellows are made by beginning the clear with lead-tin yellow, and adding ancorca to the second dye [...] and after it is dry, it is bathed in ancorca, and dried, and touching the clears with giollorino, where suitable, and squeezing the darks with the shade, leaving an excellent yellow.*' [9] (Palomino, 1947 [1715]: 50). This practice varied from region to region; for example, in northern Europe it was more common to use *stil de grain* yellow, which was sometimes referred to with the name Dutch pink. In 1620, Théodore Turquet de Mayerne wrote of '[...] *massicot shaded off with Dutch pink* [...]' (Fels. 2010: 141).



Finally, we considered the overlaying of Naples yellow ochre and orpiment (Fig. 3, samples 14-15), two pigments that are relatively opaque but that appear in stratigraphies in a preliminary application of ochre.

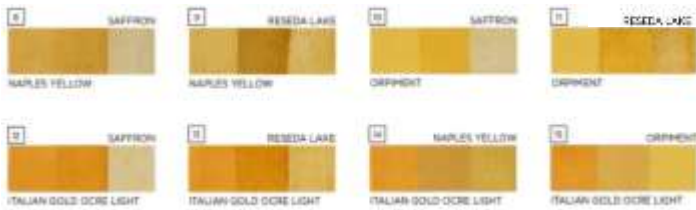


Fig. 3. Yellow samples. 8) saffron over Naples yellow; 9) reseda over Naples yellow; 10) saffron over orpiment; 11) reseda over orpiment; 12) saffron over ochre; 13) reseda over ochre; 14) Naples yellow over ochre; 15) orpiment over ochre.

### 3.3. Red

Cinnabar/vermilion (mercury sulphide pigment) and minium (red lead), together with red earths, are historically the red pigments *par excellence*. None is known for being very translucent, although red lead and mercury sulphide pigments can produce this effect when used in thin layers; in fact, they have been used in this way over layers of very dark red earths, even in mural painting (Calabria et. al, 2019) (Fig. 4, samples 16-18). Most of these overlays have lead, applied both on top of red earth (Fig. 4, sample 17) and on top of cinnabar (Fig. 4, sample 18), creating a similar visual result. Cennini, for example, suggests that: 'If you would make a silk drapery either on panels or on walls, lay on the ground with cinnabar and lighten with minium, or if you like with sinopia, and lighten with giallorino on walls' [10] (Cennini, 1971 [s. XIV]: Ch.CXLIV).

However, this overlay was less common than those done with red lake, the queen of the glazes in the red range. Red lake pigments were usually made with madder but dye lakes, Kerria lacca or Indian lake (lac dye) and, to a lesser extent, kermes, known as the European cochineal, were also used (Herrero-Cortell, 2019). The application of lake pigments as glazes over layers of inorganic reds was widespread, although occasionally they formed localised glazes. In his treatise, Da Vinci specifies the following procedure: '[...] to make a fine green take green and mix it with bitumen and you will make the shadows darker. Then, for lighter [shades] green with yellow ochre, and for still lighter green with yellow, and for the high lights pure yellow; then mix green and turmeric together and glaze every thing with it [...]' [11] (Da Vinci, The Notebooks: Ch. IX).

The hues of the lake pigments are varied and may cover a wide spectrum of reds depending on the method they were processed with and also on the colourant used. Madder lake covers the widest spectrum of reds, ranging from a pink-orange to a violet red, and including carmine, deep red and maroon. The lake sequence over cinnabar/vermilion was used constantly from the 14th through to the 19th century; it is among the most cited in the literature and probably one of the most frequently found in stratigraphies (Fig. 4, sample 19-21). All over Europe in the 14th and 15th centuries it was common to add a little of saffron when tempering minium or vermilion to give them a warmer hue, since they sometimes could look quite cold (Thompson, 1956: 108). A madder lake glaze applied over minium was also very common, resulting in a deep red-orange colour (Fig. 4, samples 22-23). Under the lake glaze there is often a mixture of several reds (such as vermilion, minium and lake) and white lead, as the underlying combinations of lakes are often the pink tones resulting from the same lake mixed with white lead (Fig. 4, samples 24-25). Thus, for example, in his treatise Théodore Turquet de Mayerne suggests: '[...] [Take] lake and white, and if you want, glaze with lake. The work will be very beautiful. [Or] lake, vermilion and white. You can glaze it with lake [...]' (Fels, 2010: 14).

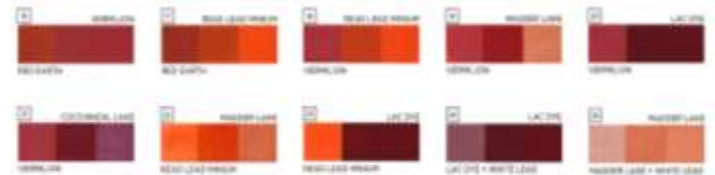


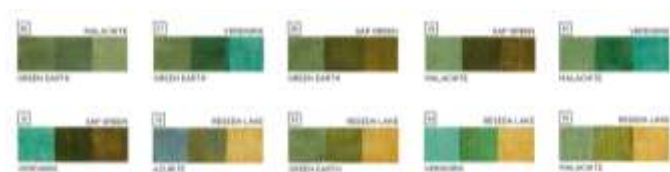
Fig. 4. Red samples. 16) vermilion over red earth; 17) red lead over red earth; 18) red lead over vermilion; 19) madder lake over vermilion; 20) lac dye over vermilion; 21) cochineal lake over vermilion; 22) madder lake over red lead; 23) lac dye over red lead; 24) lac dye over a mixture of lac dye with white lead; 25) madder lake over a mixture of madder lake and lead white.

### 3.4. Green

Due to their transparent nature, greens were used a great deal as glazes, in one or more layers over a *grisaille* in black and white, as recommended, for example, by Pacheco, who maintains that: '[...] some [greens] are fashioned with black and white in oil and then bathed in ground verdigris with linseed oil' (Pacheco, 1990 [1649]: 484) [12].

The use of verdigris with varnish (which itself produces an amber colour), or of copper resinate, is well documented throughout the literature, including the

writings of Armenini (1587: 126) and De Mayerne (Fels, 2010: 139, 142), according to the precept appearing in the Brussels manuscript: '[...] *To make very beautiful green for glazing, verdigris must be used with varnish*' [13] (Merrifield, 1967: 812). But verdigris was not the only pigment that could be used for this purpose: many green earths, for example, are highly transparent when tempered with oil, but their tone is not generally either saturated or vivid (Dörner, 1998: 75). Sometimes they were used as glazes over other colours, such as ochre or Sienna, indigo or a *grisaille* modulated over black, as recommended by Palomino (1988: 505), and they often served as a base for a glaze with a different green or yellow. When malachite is overlaid, the tone is also more consistent, and tends to have more body (Fig. 5, sample 26). These stratified layers were commonplace and are documented in painting: a cheaper pigment, like earth, was applied under a more expensive one, like malachite, which is quite transparent. It was more common to use verdigris or copper resin for glazes over green earth and then to apply malachite over that, thereby producing darker and deeper tones (Fig. 5, samples 27, 30). In some cases an organic green could be used, such as sap green, which is translucent like other lakes, although it has a brownish and less vivid tone, which is why most writers did not consider it to be among the 'noble' colours.



*Fig. 5. Green samples. 26) Malachite over green earth; 27) verdigris on green earth; 28) sap green over green earth; 29) sap green over malachite; 30) verdigris over malachite; 31) sap green over verdigris; 32) reseda lake over azurite; 33) reseda lake over green earth; 34) reseda lake over verdigris; 35) reseda lake over malachite.*

In other cases, green was produced by overlaying a yellow (always in the form of a lake) on a preceding green or blue like azurite (Fig. 5, sample 32), as recommended by Eraclius: '[...] *If you wish to make a colour like lily green, mix azure with white lead; shade it with azure; lay on the lights with white lead; and when it is dry, cover it over with clear saffron*' [14]. (Merrifield, 1967: 257). Indeed, the addition of yellow dyes to verdigris to make a colour that was less cold is a constant in the literature. There are numerous recipes for verdigris, including, for example, the addition of reseda or saffron while crushing and preparing the mixture, or even making

a verdigris blend with certain dyes to apply the final glaze, as recommended by Da Vinci: '[...] *then mix green and turmeric together and glaze every thing with it*' [...]. (Da Vinci, The Notebooks: Ch. IX) [15]. He recommends the same with saffron, unless it becomes discoloured quickly, and with yellow from aloe: '[...] *Supposing the Verdigris has already been used, and the part finished, you may then glaze it thinly with this dissolved Aloe, and it will produce a very fine colour*' [...]. [16] (Da Vinci, 1817, [16th century], Ch. CCXXIX). The greying tendency of verdigris can be definitively corrected by adding a yellow lake pigment, which results in a deeper and more saturated colour (Fig. 5, sample 34), although it is common for yellow lakes to appear over other greens (Fig. 5, samples 33-35).

### 3.5. Purple

Traditionally associated with dyes, purple is a compound colour, although some purples can be made using a violet lake pigment, such as orchilla or cochineal, over a *grisaille* base (Fig. 6, sample 37). Orchilla is a material rarely mentioned in the treatises, although Palomino (1947 [1715]: 1164) decided to include it in the list that appears at the end of his treatise containing the most commonly found colours on the painter's palette. Most of the purples used were mixtures of a pigment and a blue or red dye, or overlays of glazes created with a transparent blue or red, as recommended by Théodore Turquet de Mayerne: 'Purple is made with smalt and lake [...]' (Fels. 2010, 141).

Indeed, the best violet tones are obtained by mixing or overlaying red lake over smalt or lapis lazuli (Fig. 6, samples 38-40), according to a practice previously described by Cennini (1971 [s. XIV]: Ch. LXXIII).

*Fig. 6. Purple samples. 36) Coccheneal lake over indigo;*



*37) cochineal lake over a mixture of such lake with white lead; 38) cochineal lake over smalt; 39) cochineal lake over azurite; 40) cochineal lake over lapis lazuli*

### 4. Conclusions

What colours would we see if we entered the studio of an artist from the past who had just finished a painting? What did the colours look like before the oil or varnishes

altered the appearance of the paint with their natural oxidation? And how would they look if they had never undergone the (sometimes aggressive) cleaning processes they were subjected to?

This article has presented a reflection on the artistic literature, in the form of treatises, which provide very few guidelines for the reproduction of the recipes, but which document workshop practices that have provided the information needed to reconstruct 40 colour overlays made with pigments and dyes, agglutinated with linseed oil used as a medium for the glazes. The picture this provides is immediate: it not only offers a kind of baseline, but also facilitates a much-needed reflection on which glazes can actually change the colour tones and our perception of those colours.

## 5. Conflict of interest declaration

The authors wish to state that no financial or personal interests have affected the objectivity of the study, and that no conflicts of interest exist.

## 6. Funding source declaration

Authors wish to state that no external funding has been involved for this study.

## 7. Acknowledgment

The authors wish to thank Anna Victòria Pedret and Andrea La Bella, for their help in the developing of the study. They also wish to thank Departamento de Comunicación Audiovisual, Documentación e Historia del Arte from the Polytechnic University of Valencia (UPV), for supporting the translation costs.

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## Notes

[1] [...] *Ac deinceps accipe colores quos impugner volueris, terens eos diligenter oleo sine aqua, et fac mixturas vultuum ac vestimentorum sicut superius aqua feceras [...].*

[2] *Quando un colore trasparente è sopra un altro colore variato da quello, si compone un color misto diverso da ciascuno de' semplici che lo compongono. [...] E così il paonazzo dato sopra l'azzurro si fa di color di viola; e quando l'azzurro sarà dato sopra il giallo, egli si farà verde; ed il croco sopra il bianco fa giallo; ed il chiaro sopra l'oscurità fa azzurro, tanto più bello, quanto il chiaro e l'oscuro saranno più eccellenti.*

[3] Pacheco states: '*Los Azules bañados no los apruebo, si no es con ultramarino*'.

[4] Palomino states: '*se usa de él en dos maneras; o bañado, o labrado sobre cualquiera de los otros azules ya concluidos*'.

## *The Changes of Transparent Colours in Being Laid upon Others': Considerations for a New Perception of Glazes with Historical Pigments and Dyes*

[5] The original text says: '[...] *indicum incidet de lazurio, matizabis de albo plumbo* [...].'

[6] Palomino states: '[...] *habiendo de ser labrado, se pueden ir metiendo sus tintas de claro, y obscuro, mezclándole, en proporción, con el albayalde de nueces, y ayudando los oscuros fuertes con el añil*.

[7] The original text says: '*Azurro (...), smaltino, e biadetto, s'ombrano con indico, laca e negro.*'

[8] Cennini states: '[...] *guardati non vegga l'aria, chè perde subito suo colore* [...].'

[9] '*Los escarolados se hacen comenzando el claro con el géluli, y añadiéndole ancorca a la segunda tinta [...] y después de seco, le dan un baño de ancorca, y secante, y tocarle los claros con genulí, donde es conveniente, y apretarle los oscuros con la sombra, y queda un amarillo excelente*'

[10] Cennini states: '*Se vuoi fare drappo di seta, o in tavola o in muro, campeggia di cinabro, e pallia o ver vitica di minio; o vuoi di sinopia, e pallia di cinabro* [...].'

[11] Leonardo da Vinci states: '*Per fare un rosso bello: toglí cinabrese e mista con anguria arsa pell'ombre iscure, e pelle più chiara, matita e minio, poi vela con lacca bella* [...].'

[12] Pacheco states: '[...] *se labran algunos con blanco y negro a olio y después lo bañan con cardenillo molido con aceite de linaza*'.

[13] '*Pour faire de très beau verd galssé, faut employer le verdigris avec du verny* [...].'

[14] The original text says: '*Si vis facere clorem similem gladio viridi, misce lazurium cum albo plumbo, et quando fuerit siccus, coperi de claro croco* [...].'

[15] Leonardo states: '[...] *di poi toglí verde e curcuma insieme e vela sopr'ogni cosa*'.

[16] Leonardo states: '[...] *e se tu avessi finito un'opera con esso verde semplice, e poi sottilmente la velassi con esso aloe (risuluto in aqua), allora essa opera si farebbe di bellissimo colore* [...].'

## References

Armenini G.B. (1587). *De veri precetti della pittura*. Ravenna.

Bensi, P. (1980). 'Gli arnesi dell'arte. I Gesuati di S. Giusto alle Mura e la pittura del Rinascimento a Firenze', *Studi di Storia delle Arti*, n 3, pp. 33-47.

Brunello, F. (1975). *De arte luminandi e altri trattati sulla tecnica della miniatura medievale*, Neri Pozza, Vicenza.

Bruquetas, R. (2002). *Materiales y técnicas de la pintura Española de los Siglos de Oro*, Madrid: Fundación de Apoyo a la Historia del Arte Hispánico.

Burnstock, A. (1988). The Fading of the Virgin's Robe in Lorenzo Monaco's 'Coronation of the Virgin', *National Gallery Technical Bulletin*, 12, pp. 58-65.

Calabria Salvador, I. & Zalbidea Muñoz, A. (2019). Estudio de las pinturas murales de la sala del Mosaico de los Amores de la ciudad íbero-romana de Cástulo, *Ge-conservação/conservação* (16), 45-61. doi: <https://doi.org/10.37558/gec.v16i0.663>

Cennini, C. (1971) *Il libro dell'Arte*, A cura di F. Brunello, Vicenza: Neri Pozza.

Da Vinci, L. (1817) [s. XVI]. *Trattato della pittura*, Rome.

Da Vinci, L. (1970) [s. XVI]. *The Notebooks of Leonardo Da Vinci, compiled and edited from the original manuscripts by Jean paul Richter*. London: Dover.

Da Vinci, L. [s. XVI]. *The Notebooks of Leonardo Da Vinci*, Available at: [https://en.wikisource.org/wiki/The\\_Notebooks\\_of\\_Leonardo\\_Da\\_Vinci/X](https://en.wikisource.org/wiki/The_Notebooks_of_Leonardo_Da_Vinci/X) (Accessed: 8 July 2020).

Del Vescovo, P. (2013). Il trattato di Teofilo come testimonianza della storia dell'origine della pittura ad olio: un esempio di metodo interdisciplinare nello studio di una tecnica pittorica. In: *Zwischen Kunsthandwerk und Kunst: Die, Schedula diversarum artium*. De Gruyter, pp. 244-255.

Doerner, M. (1998). *Los materiales de la pintura y su empleo en el arte*, 3rd ed. Barcelona: Reverté.

Fels, D. (ed.) (2010). *Lost secrets of flemish Paintings*, 3rd ed. Eijsden: Alchemist Publications.

Herrero-Cortell, M. (2019). 'Los colores de un Imperio' Hispanic production and international trade of pigments and pictorial materials in the sixteenth century', *Journal for Art Market Studies*, 3(2), pp.1-16.

Hawthorne, J. et al. (1979). *Theophilus on Divers Arts: the foremost medieval treatise on painting, glassmaking and metal-work*, Translated from the Latin with introduction and notes: New York: Dover.

Merrifield, M. (1967). *Medieval and Renaissance Treatises on the arts of painting*, 2nd ed. London: Dover.

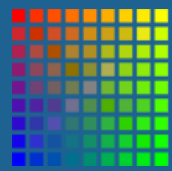
Pacheco, F. (1990) [1649]. *Arte de la pintura*, Madrid: Cátedra.

Palomino, A. (1947) [1715]. *Museo pictórico y Escala Óptica*, Madrid: Aguilar.

Price, M. (2017). *Renaissance Mysteries. Volume I: Natural colors*. London: Page publishing.

Thompson, D. (1956). *The materials and techniques of Medieval painting*, London: Dover.

Zalbidea Muñoz, M. A. (2014). *Els vernissos artístics. Revisió i evolució*, Valencia: Editorial Universitat Politècnica de València, pp. 33-37.



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**DOI:** <https://doi.org/10.23738/CCSJ130208b>

**Keywords:** pigments, lakes, dyes, glazes, color overlays

PDF

Published  
2021-11-09

Issue  
[Vol. 13 No. 02 \(2021\)](#)

Section  
Papers

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## Abstract

This article describes a reconstruction of 40 sequences of historical glazes used by most European schools of painters from the 15th to the 18th century. Its main objective is to visually document the appearance of colours overlaid with historical pigments and dyes, which have often suffered from a degree of deterioration that renders it difficult to determine their original appearance. We also seek to show the extent to which the historical glazes and overlays can alter our perception of the underlying colour. To this end, lab tests and sources have been used with the aim of suggesting a series of sequences of colour overlays that were widely used in the aforementioned period, so as to reproduce them on a canvas using historical pigments and colours agglutinated in oil, in accordance with the main painting techniques of the era studied.

## References

Armenini G.B. (1587). De'veri precetti della pittura. Ravenna.

Bensi, P. (1980). 'Gli arnesi dell'arte. I Gesuati di S. Giusto alle Mura e la pittura del Rinascimento a Firenze', *Studi di Storia delle Arti*, n 3, pp. 33-47.

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### How to Cite

"The Changes of Transparent Colours in Being Laid upon Others': Considerations for a New Perception of Glazes with Historical Pigments and Dyes" (2021) *Cultura e Scienza del Colore - Color Culture and Science*, 13(02), pp. 64-71. [doi:10.23738/CCSJ130208b](https://doi.org/10.23738/CCSJ130208b).

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Brunello, F. (1975). De arte luminandi e altri trattati sulla técnica della miniatura medievale, Neri Pozza, Vicenza.

Bruquetas, R. (2002). Materiales y técnicas de la pintura Española de los Siglos de Oro, Madrid: Fundación de Apoyo a la Historia del Arte Hispánico.

Burnstock, A. (1988). The Fading of the Virgin's Robe in Lorenzo Monaco's 'Coronation of the Virgin', National Gallery Technical Bulletin, 12, pp. 58-65.

Calabria Salvador, I. & Zalbidea Muñoz, A. (2019). Estudio de las pinturas murales de la sala del Mosaico de los Amores de la ciudad íbero-romana de Cástulo, Ge-conservación/conservação (16), 45-61. doi: <https://doi.org/10.37558/gec.v16i0.663>

Cennini, C. (1971) Il libro dell'Arte, A cura di F. Brunello, Vicenza: Neri Pozza.

Da Vinci, L. (1817) [s. XVI]. Trattato della pittura, Rome.

Da Vinci, L. (1970) [s. XVI]. The Notebooks of Leonardo Da Vinci, compiled and edited from the original manuscripts by Jean paul Richter. London: Dover.

Da Vinci, L. [s. XVI]. The Notebooks of Leonardo Da Vinci, Available at: [https://en.wikisource.org/wiki/The\\_Notebooks\\_of\\_Leonardo\\_Da\\_Vinci/IX](https://en.wikisource.org/wiki/The_Notebooks_of_Leonardo_Da_Vinci/IX) (Accessed: 8 July 2020).



Del Vescovo, P. (2013). Il trattato di Teofilo come testimonianza della storia dell'origine della pittura ad olio: un esempio di metodo interdisciplinare nello studio di una tecnica pittorica. In: *Zwischen Kunsthandwerk und Kunst: Die, Schedula diversarum artium*. De Gruyter, pp. 244-255.

Doerner, M. (1998). *Los materiales de la pintura y su empleo en el arte*, 3rd ed. Barcelona: Reverté.

Fels, D. (ed.) (2010). *Lost secrets of flemish Paintings*, 3rd ed. Eijsden: Alchemist Publications.

Herrero-Cortell, M. (2019). 'Los colores de un Imperio' Hispanic production and international trade of pigments and pictorial materials in the sixteenth century', *Journal for Art Market Studies*, 3(2), pp.1-16.

Hawthorne, J. et al. (1979). *Theophilus on Divers Arts: the foremost medieval treatise on painting, glassmaking and metal-work*, Translated from the Latin with introduction and notes: New York: Dover.

Merrifield, M. (1967). *Medieval and Renaissance Treatises on the arts of painting*, 2nd ed. London: Dover.

Pacheco, F. (1990) [1649]. *Arte de la pintura*, Madrid: Cátedra.

Palomino, A. (1947) [1715]. *Museo pictórico y Escala Óptica*, Madrid: Aguilar.

Price, M. (2017). Renaissance Mysteries. Volume I: Natural colors. London: Page publishing.

Thompson, D. (1956). The materials and techniques of Medieval painting, London: Dover.

Zalbidea Muñoz, M. A. (2014). Els vernissos artístics. Revisió i evolució, Valencia: Editorial Universitat Politècnica de València, pp. 33-37.

CCSJ DOI:10.23738/CCSJ.00 ISSN:2384-9568 ANCE:E227716 Registration n.233 of 24.06.2014 at the Court of Milan