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Survey on Van Gogh's early painting technique through the non-invasive and multi analytical study of *Head of peasant*

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Abstract

The strong lighting of the face against a dark background, the bold brushstroke and the model's expressiveness that characterize Van Gogh's *Head of peasant*, belonging to the Royal Museums of Fine Arts of Belgium collections, are typical features found in the peasant heads studies painted in Nuenen, in March–April 1885, in prevision of the well-known *The Potato Eaters*. However, this oil painting additionally testifies of Van Gogh's early experiments in regards with the laws of colors, the flesh rendering and portraying models under artificial light. In order to collect material and technical information revealing how the painter practically handled these issues, the Brussels peasant head has been investigated in situ by complementary non-invasive imaging and analytical methods. While the identified pigments strictly reflect Van Gogh's palette in Nuenen, relevant outcomes regarding the flesh tones composition, the rendered forceful expression of the figure, the effect of a face painted by lamplight, and the use of simultaneous color contrasts were achieved.

Keywords: Van Gogh, Painting, Nuenen, MA-XRF, Technical art history

Introduction

The Head of peasant (inv.4910/F163/JH687), acquired by the Royal Museums of Fine Arts of Belgium (RMFAB) in 1931 through J.-B. De La Faille, belongs to the significant series of peasant character studies Vincent Van Gogh made in Nuenen (Fig. 1). The strong lighting of the face against a dark background, the bold brushstroke and the rendered expressive figure are typical features found in the peasant heads painted in March-April 1885, in prevision of *The Potato Eaters*, the masterpiece of the artist's Dutch period, completed in May 1885.

Moreover, according to Jan Hulsker, author of the Catalogue Raisonné, the young man portrayed here in full face and the sitter shown in profile in *The Potato Eaters* (Fig. 2), are possibly one and the same [1]. Several physiognomic details, for instance the protruding ears surmounted by spiky fair hair, the bulging cheekbones and the mouth with full lips support this assumption. However, the prognathous maxillary characterizing the profile sitter in *The Potato Eaters* cannot be ascertained from the front view adopted in the Brussels's portrait. Although the hypothesis concerning the model's identity could not be confirmed, it has been suggested it could be Gordina De Groot's brother [1]. Gordina De Groot is the young woman shown in frontal view in *The Potato Eaters* [1]. This peasant woman is actually the model of multiple studies of heads Van Gogh made during his Nuenen period [1, 2].

In any case, the RMFAB's *Head of peasant* perfectly illustrates Van Gogh's concerns of that time, in regard to the lighting (Letters to Theo van Gogh [3]: Nieuw-Amsterdam, Friday, 12 or Saturday, 13 October 1883 (395); Nuenen, Wednesday, 30 April 1884 (445); Nuenen, Thursday, 9 April 1885 (492)), the flesh rendering (Letters to Theo van Gogh [3]: Nuenen, between about Thursday, 5 and about Thursday, 26 February 1885 (483); Nuenen, on or about Saturday,

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Fig. 1 *Head of peasant* by Vincent Van Gogh. Vincent Van Gogh, *Head of peasant* (F163/JH687), April 1885, oil on canvas, 39 × 30 cm, Inv. 4910, RMFAB, Brussels

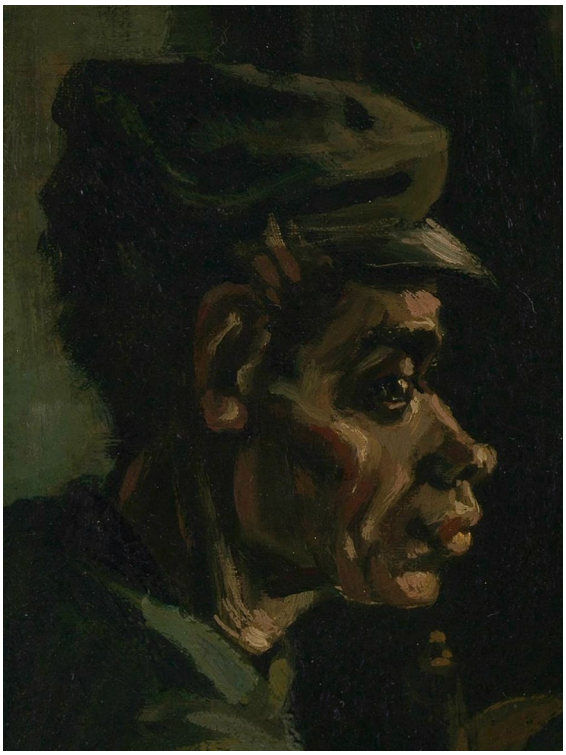

Fig. 2 Detail of The Potato Eaters by Vincent Van Gogh. Detail of the sitting young man in Vincent Van Gogh, *The Potato Eaters* (F82/JH764), April 1885–May 1885, oil on canvas, 82 × 114 cm, Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation)

2 May 1885 (499); Nuenen, on or about Saturday, 10 October 1885(534)) and the laws of colors (Letters to Theo van Gogh [3]: Nuenen, on or about Friday, 6 June 1884 (494); Nuenen, on or about Saturday, 2 May 1885 (499); Nuenen, between about Friday, 25 and about Tuesday, 29 September 1885 (532); Nuenen, on or about Tuesday, 20 October 1885 (536); Nuenen, on or about Wednesday, 28 October 1885 (537); Antwerp, Monday, 14 December 1885 (547)). During this period, Van Gogh color perception is changing from paintings using local colors in the autumn of 1882 in The Hague to a freer, coloristic use during the Nuenen period [4–7]. Van Gogh tried to follow the works of Charles Blanc on Delacroix [8] who had attempted to put Chevreul's laws of simultaneous contrast [9] into practice. Blanc followed the laws of simultaneous contrast and the possibilities for optical mixtures. He proposed the color system is defined by a circle containing six opposing triangles in which the additive primaries of red, yellow and blue alternate with the subtractive primaries of orange, green and violet. In the autumn of 1884, Van Gogh finds practical methods for his coloristic goals by linking to Blanc's account of *tons rompus*, halftones achieved by mixing complementary colors. Van Gogh introduced a fourth scale consisting of completely neutral color tones, from black to white, where white is the lightest possible and black the darkest possible three-color mixture.

In order to gain relevant information on how the painter practically handled these issues in the present portrait, this one has been investigated through complementary non-destructive imaging and analytical methods. The methods used for this purpose include infrared reflectography (IRR), X-ray radiography (XRR), high-resolution photography, Raman spectroscopy (RS), digital microscopy, and scanning X-ray fluorescence (MA-XRF). This paper presents an overview of the collected material and technical information revealing Van Gogh's tricks to render lighting, expressiveness and flesh tones, and to create simultaneous contrasts.

Experimental

A high-resolution photographic documentation has been performed. The full size images in visible light and under ultra violet light have been acquired by using the homemade scanning system of the CEA [10] and a D7500 Nikon® camera with an AF-S Micro Nikkor 105mm Nikon® objective. Each close-up is recording a 4cm ×

3cm area of the painting. The images are then stitched as a panorama view with PTGui software®. X-ray radiography was performed using a mobile X-ray radiography system with an X-ray source at 40kV (X-ray side window Oxford-Intrument® Series 5000) and an Alpha-R-4000 digital detector (40cm × 40cm) from Teleoptic®. Infrared reflectography was acquired using an Osiris camera (Opus Instruments®) sensitive in the 0.9–1.7 μm and halogen lamps. Additionally, the painting surface has been examined with a digital microscope (Dino-Lite®). The multispectral images are reported in Fig. 3.

In order to obtain to get a better understanding of the pigments distribution through elemental maps, XRF (X-ray fluorescence) spectroscopy was used in macro scanning mode (MA-XRF). The XRF scan (180mm x 185mm) of the painting has been completed in approximately 4h by using the AAP translation stage and XRF system [11, 12], made of a Moxtek® Magnum X-ray tube (50kV) (with an Ag anode), a detector X-123SDD Amptek® (25 mm^2), with a resolution of 130 eV at 5.9 keV. Scanning step was set to 1mm with a dwell time of 300 μs. X-ray tube was set to a voltage of 40kV and a

Fig. 3 *Head of peasant*: multispectral imaging. Detail of *Head of peasant*: **a** Photography. **b** photography with raking light. **c** photography using UV light. **d** UV induced luminescence photography . **e** Infrared reflectography. **f** X-ray radiography

current of 100 μA. Spectra were treated in batch mode using PyMCA [13], allowing separation of the signals from the different chemical elements.

The analyses by Raman spectroscopy (RS) were performed with the Enwave Optronics® setup (portable Raman analyzer I-Dual-G), using a laser at 785 nm [14]. Three Raman spectra were acquired for each of the twelve investigated sites, with the lowest laser power necessary to obtain valuable results (ca. 30mW). The recorded spectra were treated using GRAMS®. Unfortunately, because of the thick varnish layer present on the painting only a few of the Raman spectra were useful.

Data and images were all acquired on the museum site thanks to our mobile laboratory.

Results and discussion

Flesh rendering

First of all, the examination of paint losses under microscope revealed the presence of a single white ground layer without visible colored particles. The elemental composition outlined by the MA-XRF analysis (Fig. 4), supports the use of a lead white ground without calcite and/or barite contents, such as those found out in the grounds of Van Gogh's later paintings [7, 15].

On the basis of the obtained Raman and MA-XRF results, flesh tones are basically made from iron oxide/hydroxide pigments and lead white mixtures, admixed with variable proportions of lead white, zinc white, Naples yellow, vermilion and an organic red (detected by Raman), throughout the model's face. A close examination of the paint layers implementation also allowed concluding the brightest colors, which include the light flesh tones and the highlights in the eyes, the nose, the lips, the proper left ear, the buttons, the collar and the cap, have been lastly applied. These accents of light readily stand out from the Zn map because of their high zinc white contents. Indeed, while the scans of Pb (L-ray and M-ray), show the even and significant presence of lead white in the whole scanned region, except in the pupil and the sclera in the eyes, the Zn map indicates a more restricted use of zinc white.

The dark areas of the face are the richest in ferrous pigments. Thanks to the MA-XRF analysis and the IRR method it was possible to outline the use of at least three

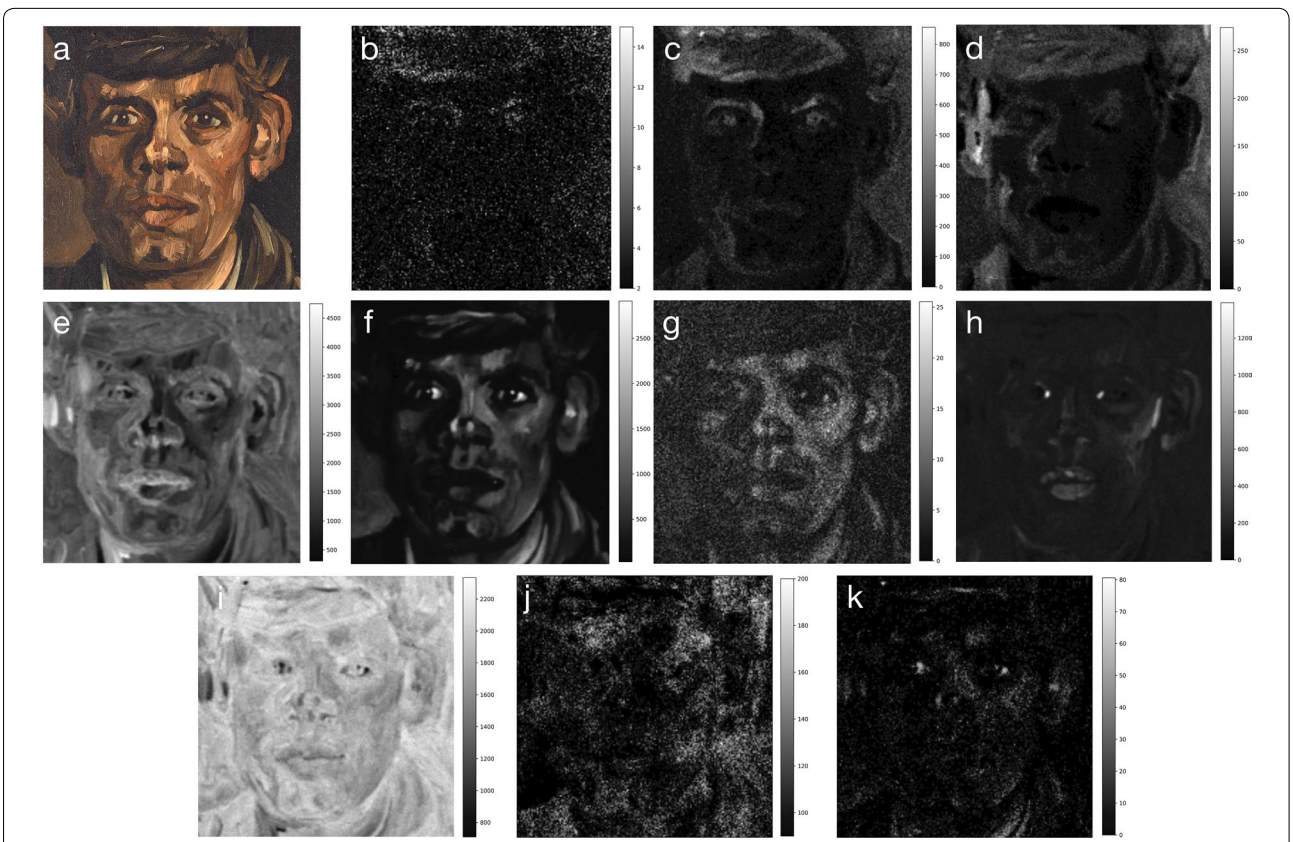

Fig. 4 *Head of peasant*: MA-XRF imaging. MA-XRF imaging: **a** Visible photography, **b** Phosphorus distribution, **c** Calcium distribution. **d** Manganese distribution. **e** Iron distribution. **f** Zinc distribution. **g** Antimony distribution (K-ray). **h** Mercury distribution (L-ray). **i** Lead distribution (L-ray). **j** Lead distribution (M-ray). **k** Bismuth distribution (L-ray)

different iron oxide/hydroxide pigments, notably for rendering shadows (Fig. 5): (1) manganese free appearing transparent in the IRR, (2) manganese free, appearing dark in the IRR, (3) containing manganese and appearing dark in the IRR. The brown color using a ferrous pigment, without Mn contents and transparent to IR, can be visualized by comparing the visible and the IRR images, chiefly on a level with the eyes. This brown must have been posed at an early stage of the making process, since it is lying beneath the iris, the pupil, the sclera of the eyes, but also beneath the flesh tones from all around. The iron pigment without Mn contents, but absorbing IR, is associated with the reddish brown brushstrokes visible in the mouth, the left temple and the nose tip. The Fe pigment associated with Mn, presumably umber [16], is correlated with the darkest colors. The Fe, Mn, Ca and P distribution maps suggest the combined use of umber and ivory black in the iris of the eyes, in the eyebrows and in the blackish outlines of the cap and the garment. Neither of the two pigments, though, was detected from the iron based black touches used for depicting nostrils.

The illuminated parts of the face differ from the shadows through the decreasing intensity of the Fe signals and more intense signals of Zn and Sb ascribed to zinc white and Naples yellow, respectively. The Hg distribution map, makes readily visible the vermilion based brushstrokes in the eyes, the mouth and the right cheek, and points out the little use of this red pigment elsewhere. It is interesting to note that similar proportions of Naples yellow and vermilion were unveiled in the flesh tones of the woman head, probably made in April 1885 hidden behind *Patch of Grass*, 1887 [17, 18]. However, the pinkish particles observed in the lightest flesh tones of our young man, such as the highlights on the nose tip, support the use of another red pigment. The related Raman spectra recorded from the proper left cheek share an absorption band at ca. 1260 cm^{-1}, which could be induced by an organic red, such as Carmine [19].

Simultaneous contrasts

The very dark background surrounding the young man can be found in other Van Gogh's Dutch paintings [20]. However, here, simultaneous color contrasts, but also tonal contrasts, emerge from the bright reddish flesh tones presented against the green-brown shades of the background, the cap and the garment.

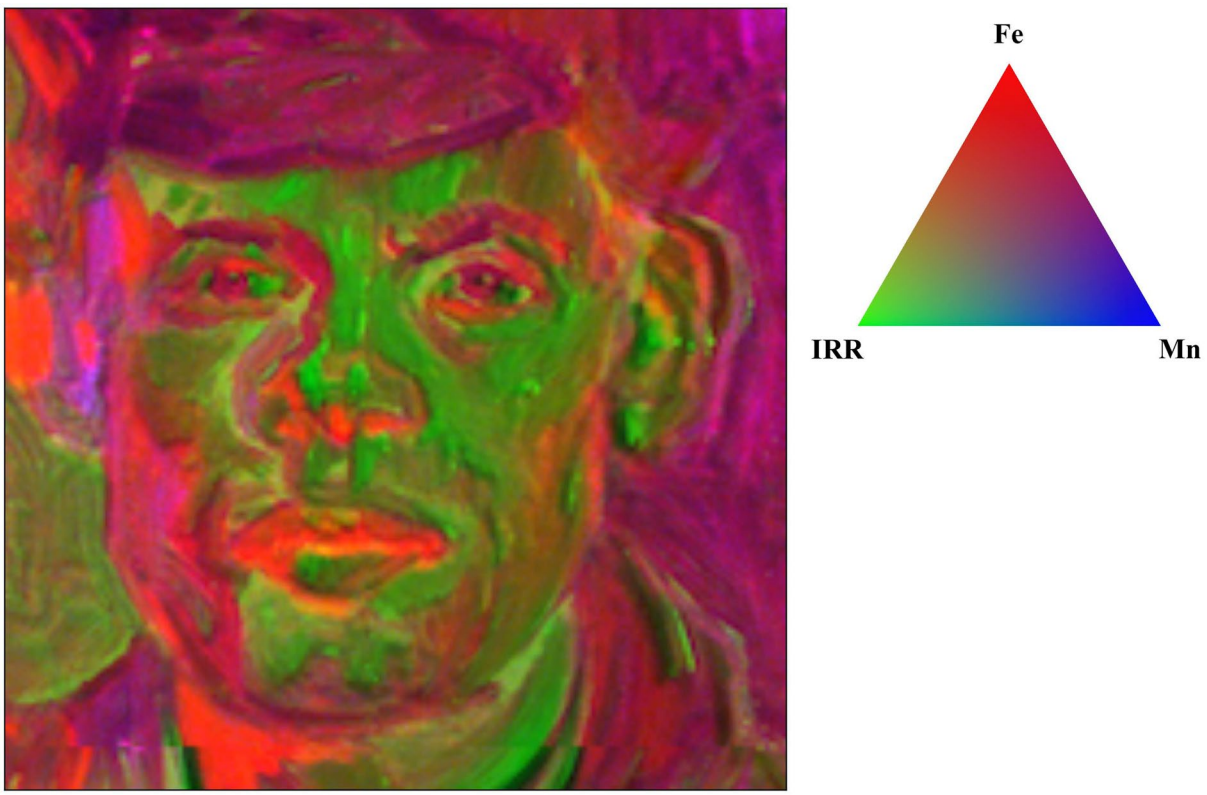

Fig. 5 *Head of peasant*: IRR-Fe-Mn distribution. Superposition of the infrared reflectography (Green color: G = 100 if transparent to IR and G = 0 if opaque), Iron distribution (Red color: R = 100 if Fe signal is maximum and R = 0 if Fe is minimum) and Manganese distribution (Blue color: B = 100 if Mn signal is maximum and B = 0 if Mn is minimum)

Several letters addressed to Theo and dated between 1884 and 1885 [3], for instance letters 494 (Nuenen, on or about Saturday, 18 April 1885) and 538 (Nuenen, Tuesday, 3 or Wednesday, 4 November 1885), are very explicit about the painter's growing interest for the laws of colors. Moreover, certain works from that period, such as *Head of a woman* of April 1885 (Van Gogh Museum, Amsterdam, F160), within the red cap and the green dress create simultaneous contrasts, clearly testify of his attempts to put them into practice (Nuenen, on or about Tuesday, 20 October 1885 (536)). In view of this, the Brussels painting cannot be dissociated from Van Gogh's colors experiments, driven by the theory of complementary colors.

The distributions of Fe, Mn, Sb, Pb, Zn, Ca and P elements in the background, the cap and the garment regions, unveil complex mixtures made from iron oxide/hydroxide pigments with and without Mn contents, Naples yellow, lead white, zinc white and ivory black, in variable proportions. Despite appearances, no green pigment was found out. Even if Van Gogh did already use Emerald green at that time [7], the absence of green pigment is not so surprising if one considers Van Gogh's early palette principally consisted of primary colors (red, blue, yellow), used in different ways and varying proportions (letter to Theo van Gogh, The Hague, Saturday, 5 August 1882 (253)). Consequently, the observed green shades should result from the low-level presence of Naples yellow and a blue pigment made of light elements, such as Ultramarine blue, in the mixtures. The darkest areas displayed in the background, the cap and the garment are the richest in umber and in ivory black, just as in the face.

The zinc white based highlights, placed in the eyes, the collar, the buttons and the cap, equally appear greenish. The blue, presumably Ultramarine, and yellow particles observed under digital microscope seem to be responsible for the light green shade they similarly exhibit. It must be noted here that the circulation of a same color throughout a picture will become recurrent in Van Gogh's later works. One more time only Naples yellow was successfully identified, but here weak signals of bismuth were additionally detected. Whereas, Naples yellow could easily explain the detection of this element, the Bi distribution map appears more correlated with the one of Zn than with the one of Sb [21, 22]. In any case, the light green features painted against dark colors create strong color contrasts.

Forceful expression

As mentioned above, zinc white is especially prominent in the bright colors applied at the end of the making process, for instance the accents of light in the face, the cap and the garment. These surface painted layers are also characterized by a more vigorous and more apparent brushstroke, which certainly emphasizes the angular face and the penetrating eyes of the model. In comparison, the dark colors seem more smoothly brushed. Furthermore, one can see from the transmitted light image that they were spread out into thinner layer. These findings support the assumption about how and for which reasons Van Gogh did employ zinc white and lead white within a same painting [7, 23]. Indeed, according to these authors, the painter would have taken advantage of specific properties of zinc white, such as its effectiveness for creating impastos, but would have preferentially used it in the surface layers for a reason of drying time, he considered too slow (Arles, on or about Sunday, 1 April 1888 (591)). Moreover, zinc white has a brighter and more neutral tone than lead white, and results in a more transparent paint layer [7, 23].

Regarding the expressiveness, it must be noted that the small greenish touches in the sclera of the eyes, and the tear duct painted with vermilion, are positioned side by side (Fig. 6, right). The simultaneous contrasts created by juxtaposing red and green colors within the eyes, should contribute greatly to the forceful expression of the figure. The examination of the eyes under microscope pointed out another significant detail. That is the tiny blue dot

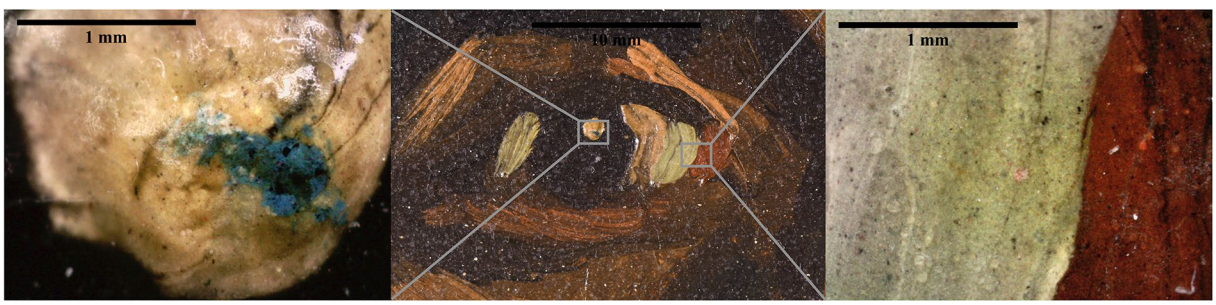

Fig. 6 Sample figure title. Detail of the left eye making (center) showing the tiny blue dot placed on the pupil and (left) and the simultaneous contrasts created by juxtaposing red and green colors side by side (right)

painted probably with ultramarine on the top of the left pupil, which is likely to stress the penetrating gaze of the model (Fig. 6, left). In the future, it would be of course relevant to verify the presence or absence of such tiny detail in the eyes of further peasant heads by Van Gogh.

Lighting

The strong light falling on the model's face against a very dark background is compliant with a work painted by lamplight. Moreover, we know from his correspondence Van Gogh did paint peasants by lamplight in Nuenen cottages (Letters to Theo van Gogh: Nuenen, on or about Monday, 2 March 1885 (484); Nuenen, Thursday, 9 April 1885 (492); Nuenen, on or about Saturday, 2 May 1885 (499); Nuenen, on or about Tuesday, 14 July 1885 (515)), notably in the one of Gordina De Groot. In March 1885, the painter wrote in letter 484:

> *At present I'm painting not just as long as there's light, but even in the evening by lamplight in the cottages, if I can somehow make things out on my palette, in order to capture if possible something of the singular effects of lighting at night, for instance with a large shadow cast on the wall.*

As previously described the illuminated parts of the face are characterized by higher contents in zinc white. Though, there is another important point regarding the advantages of zinc white compared with lead white: in mixtures it better allows conserving the brightness of the colors [7, 24]. One can therefore assume the preferential use of zinc white in the brightest colors was not achieved by accident but aimed at promoting the emergence of strong tonal contrasts, giving the impression of a head painted at night, by lamplight.

Conclusion

In conclusion, the palette disclosed for the RMFAB's *Head of peasant* incorporates lead white, zinc white, Naples yellow, at least three different iron oxide/hydroxide pigments, possibly ultramarine, vermilion, an organic red and ivory black. These pigments strictly reflect Van Gogh' palette in Nuenen; that is to say a limited palette based on the primary colors [7, 25, 26]. An interesting outcome in respect of flesh tones is that Naples yellow and vermilion were used in the same way as for the 1885 head of the peasant woman, lying underneath *Patch of Grass*, 1887.

The Brussels' painting display tonal contrasts and different degrees of simultaneous color contrasts, revealing Van Gogh's great enthusiasm for the theory of complementary colors, he had freshly discovered through Blanc's books. The preferential use of zinc white in the illuminated parts of the face should be at least partly responsible for the impression of a head painted under artificial light. The presence of zinc white in surface layers, the bolder brushstrokes associated with, and the circulation of a same color throughout the picture, a very light green in the present case, are all technical specificities commonly encountered in Van Gogh's later works.

In regards with the forceful expression of the figure, the tiny blue dot painted on the top of the left pupil and the simultaneous color contrasts arising within the eyes, most probably play a key role in the rendered penetrating glaze. In the same way, the more visible and more vigorous brushstrokes associated with the brighter colors, reinforce the angular face of the model.

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Authors' contributions
CD and DS have realized the in situ measurements (imaging, XRF and Raman), CD, DM, DS and FV have interpreted the results of the analysis. All authors read and approved the final manuscript.

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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