



Rembrandt Now

Technical Practice, Conservation and Research

Edited by Marika Spring and Ashok Roy

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Preface

To coincide with the exhibition *Rembrandt: The Late Works* (15 October 2014–18 January 2015) at the National Gallery in London and co-organised with the Rijksmuseum, Amsterdam, a three-day scholarly conference *Rembrandt Now: Technical Practice, Conservation and Research* (13–15 November 2014) on Rembrandt's technical practice for painting was hosted at the National Gallery.

While the exhibition focused on Rembrandt's paintings from the early 1650s until the end of his career, the conference papers considered the results of technical research on Rembrandt spanning the whole of his career and included papers given by Rembrandt experts from the Netherlands, Germany, Belgium, France, the USA and Britain. The contributions also covered new revelations brought about by major conservation treatments of paintings by Rembrandt in the five years prior to the exhibition, as well as through the application of newer analytical and imaging technologies. The conference also included a paper (contained within this volume) given in tribute to Dr Karin Groen (1941–2013), a renowned Dutch conservation scientist, whose ground-breaking work elucidated the material nature and techniques of a great range of Dutch 17th-century paintings, at the centre of which was a particular interest in the works of Rembrandt. The keynote lecture of the conference ('The relevance of research on Rembrandt's painting technique') was

given by the leading scholar in Rembrandt technical research and its application to interdisciplinary studies of the painter's work, Professor Ernst van de Wetering (1938–2021), former director of the Rembrandt Research Project, founded by the NWO in the Netherlands in 1968. This volume, generously sponsored by the Siebold Stichting Foundation, which also provided full support for the conference, brings together a selection of the papers presented at the conference.

*This volume is dedicated to the memory of
Karin Groen and Ernst van de Wetering*

Supported by the Siebold Stichting Foundation and Fukushima Medical University. Alongside supporting exhibitions and publications devoted to Dutch art of the seventeenth century, the Siebold Stichting Foundation works with Fukushima Medical University on art therapy projects to help those affected by the 2011 tsunami in Japan.

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Cover image: Detail from Rembrandt, *A Woman Bathing in a Stream (Hendrickje Stoffels?)*, 1654. © The National Gallery, London.

Four paintings by Rembrandt in the National Gallery, London, examined using infrared reflectography

Rachel Billinge

ABSTRACT The paintings by Rembrandt in the National Gallery have been studied extensively over many years but infrared reflectography (IRR), a method to detect underdrawing used regularly at the NG to study other works – from early Italian to nineteenth-century French paintings – had never been carried out. Infrared photographs had been taken of some of the paintings and although interesting they are rather limited in what they can show, therefore it was decided to investigate whether IRR would reveal more information. Four small panel paintings were chosen for this study: *A Woman Bathing in a Stream* (NG 54) of 1654 and three earlier pictures, *The Woman Taken in Adultery* (NG 45), *The Lamentation over the Dead Christ* (NG 43) and *Anna and the Blind Tobit* (NG 4189). This paper presents the results of the IRR studies which, although mixed, were interesting each in their own way.

Introduction

The paintings by Rembrandt at the National Gallery (NG), London, have been examined in depth using a wide array of scientific techniques for studies by the Rembrandt Research Project team as well as in-house for the NG's scholarly catalogues. All the paintings that were at the time attributed directly to Rembrandt were studied for the first *Art in the Making* exhibition in 1988 and the results published in the accompanying catalogue;¹ more recent work was included in the new 2006 edition.² One technique, however, had not been employed: even though the NG enjoys an enviable reputation for studies using infrared reflectography (IRR), this had not been attempted on its paintings by Rembrandt.

Some IR photographs were taken as part of the earlier research but in the 1980s IRR was a very difficult and time-consuming process. The results were delivered as a live video signal showing only a small area, which then had to be recorded by

photographing the monitor screen. For larger areas a series of photographs was taken and the individual prints joined together physically to build up IR reflectogram mosaics.

IR imaging relies on the ability of the radiation to pass through paint layers and, for the best results, depends on the existence of high levels of contrast between the area of interest and its surroundings. Thick paint can impede the penetration of IR radiation and coloured grounds reduce the contrast between the background in an image and the paint of interest. IR-absorbing pigments, such as carbon black, in the upper layers of paint can also confuse the results. It is therefore understandable that large works by Rembrandt, thickly painted in blacks and browns often on dark grounds, were not regarded as good subjects for IRR.

Since the 1980s, however, IR imaging technology has moved on. Digital sensors are now available mounted in cameras which allow large areas of a painting to be studied quickly and efficiently. It was



Figure 1 Rembrandt, *A Woman Bathing in a Stream*, 1654, oil on oak, 61.8 × 47 cm, The National Gallery, London, NG54. Photo © The National Gallery, London.



Figure 3 Rembrandt, *A Woman Bathing in a Stream*: infrared reflectogram. Photo © The National Gallery, London.

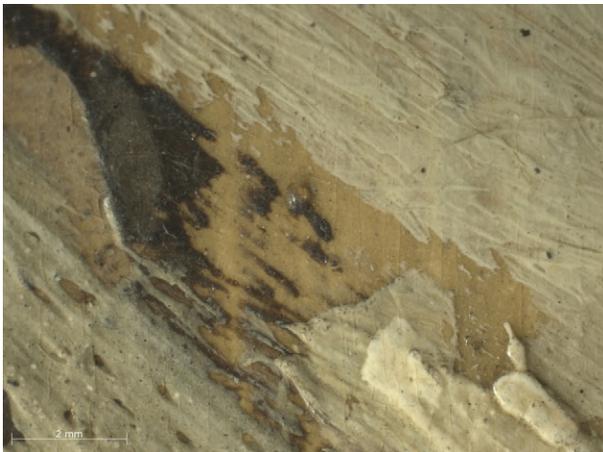


Figure 2 Rembrandt, *A Woman Bathing in a Stream*: photomicrograph of the bottom of the white shift showing exposed priming. Photo © The National Gallery, London.

decided that it might be worth trying IRR on a few paintings by Rembrandt in the NG's collection in order to get a sense of what might be possible and whether anything of interest might result from such examinations.

For this initial study, four paintings were selected. The problems mentioned earlier regarding thick

paint and dark grounds are still a factor in the success of images produced using the newer technology, so the paintings chosen were all small panels with relatively light grounds executed in the thinner paint of Rembrandt's earlier work.

A Woman Bathing in a Stream

The latest of the four works studied, *A Woman Bathing in a Stream* (NG54) dated 1654, is painted on a single piece of oak with a vertical grain (Fig. 1). It has a chalk ground over which a thin priming has been applied, described in the *Art in the Making* catalogue as 'warm brown'.³ The priming consists of a yellow-brown earth pigment, a little umber and lead white. The result is a warm buff colour which Rembrandt left exposed in places such as the bottom of the woman's shift (Fig. 2). Earth pigments, especially umbers, often absorb IR, but in this case the exposed priming areas appear as some of the brightest parts of the IR reflectogram – lighter than much of the woman's shift and flesh – suggesting that

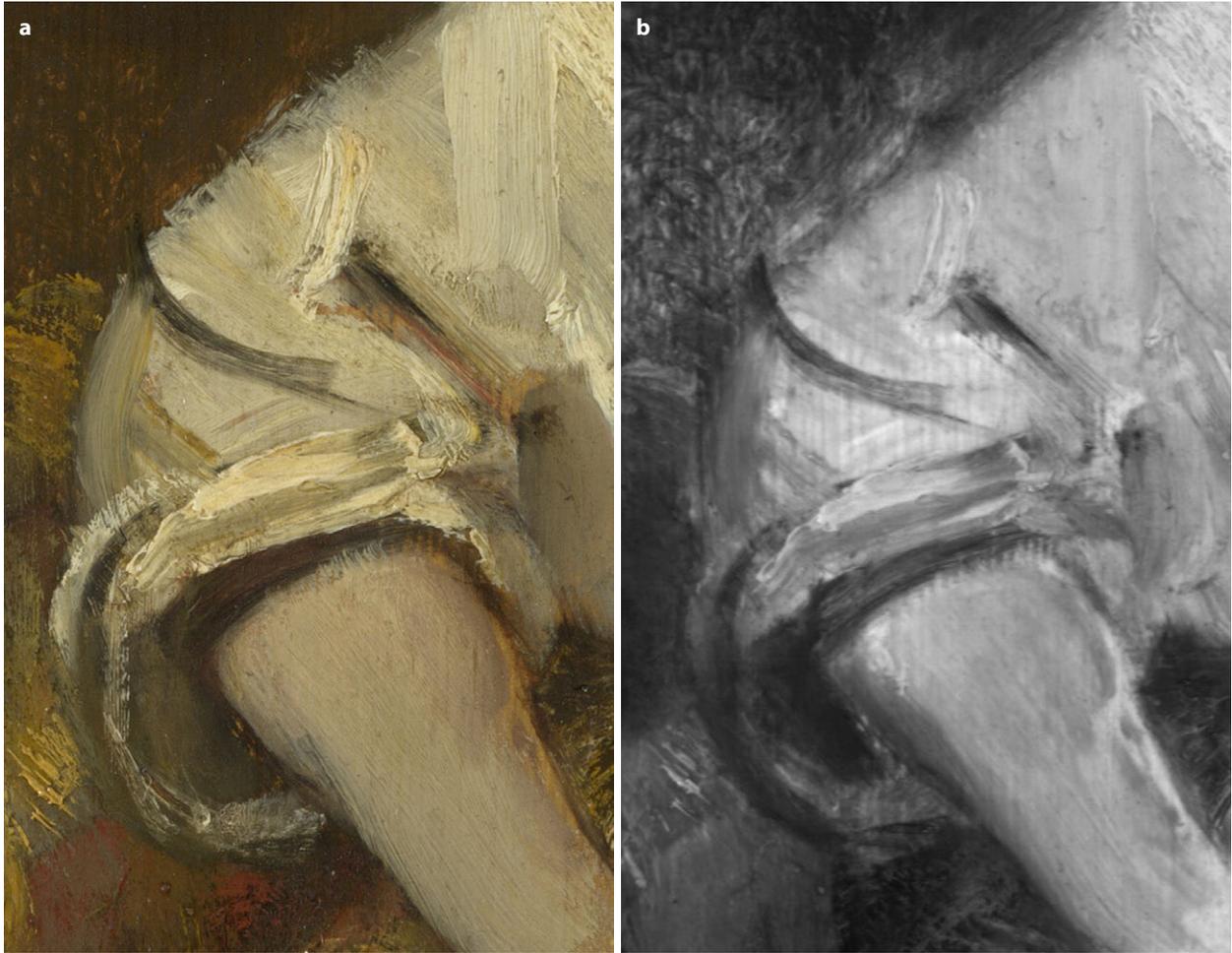


Figure 4 (a) Rembrandt, *A Woman Bathing in a Stream*: detail showing the woman's right shoulder and (b) infrared reflectogram. Photos © The National Gallery, London.

Rembrandt used black in these paints. An IR photograph of this painting had already been published in the *Art in the Making* catalogue entry,⁴ but the only reference to it in the text draws attention to the way in which the background paint was applied by 'allowing the lighter colour [of the priming] to shine through swirling glazes of black and brown.'⁵ IRR also does this very effectively (Fig. 3).

Establishing the use of underdrawing in the painting from study of the IRR image is more problematic. Some dark lines that appear to cross contours may seem to be below the final surface paint but when comparing the image with the painting, many are revealed in fact to be part of the paint application (Fig. 4a and b). Some of the dark lines in the IR reflectogram, such as those at the woman's elbow, are very clearly in the upper paint layers. The black was not the final brushstroke applied but was painted over – and into – the paint of the shift while it was

still wet. In this area there is also a line marking the turn-up of her sleeve. On the left it is clearly on top of the paint of her garment but it then disappears under the thick highlight to emerge again on the other side.

Similarly, the IRR image of the area around her hand clearly reveals strong lines around her curled fingers as well as lines indicating folds in her drapery and shadows across her leg (Fig. 5a and b) in the upper paint layers. The brown shadow at the top of her leg also causes a distinct dark line in the IR reflectogram. There are a few lines in the shift on the left that appear to be lower down in the layer structure – these indicate an early position of the lower part of the shift, later changed by Rembrandt. Under magnification these lines are clearly paint and seem to be applied directly on the priming (Fig. 6). The paint for the new position of the shift now lies over them, but it is not clear whether they would have been covered had Rembrandt not changed his mind.



Figure 5 (a) Rembrandt, *A Woman Bathing in a Stream*: detail showing the woman's right hand and upper thigh and (b) infrared reflectogram. Photos © The National Gallery, London.



Figure 6 Rembrandt, *A Woman Bathing in a Stream*: photomicrograph of the white shift by the right hand. Photo © The National Gallery, London.

In the *Art in the Making* catalogue entry there is a short discussion of some 'dark sketching [which] may well correspond to the so-called "dead-colouring" stage'.⁶ The paint identified as performing this role was described as 'reddish-brown', visible at the bottom edge of the shift. Depending on the pigments used, a reddish-brown could show clearly in IRR but unfortunately this paint disappears from the images in the few places where it can be seen from the surface, therefore if there is a 'dead-colouring' stage in this painting, IR imaging is unable to reveal its extent.

The Woman Taken in Adultery

The second painting studied, *The Woman taken in Adultery* (NG45) dated 1644, is rather more complicated (Fig. 7). The main focus of the composition is packed tightly into a small area in the lower portion of the panel and, as seems to have been Rembrandt's habitual way of working, a great many changes were



Figure 7 Rembrandt, *The Woman Taken in Adultery*, 1644, oil on oak, 83.8 × 65.4 cm, The National Gallery, London, NG45. Photo © The National Gallery, London.

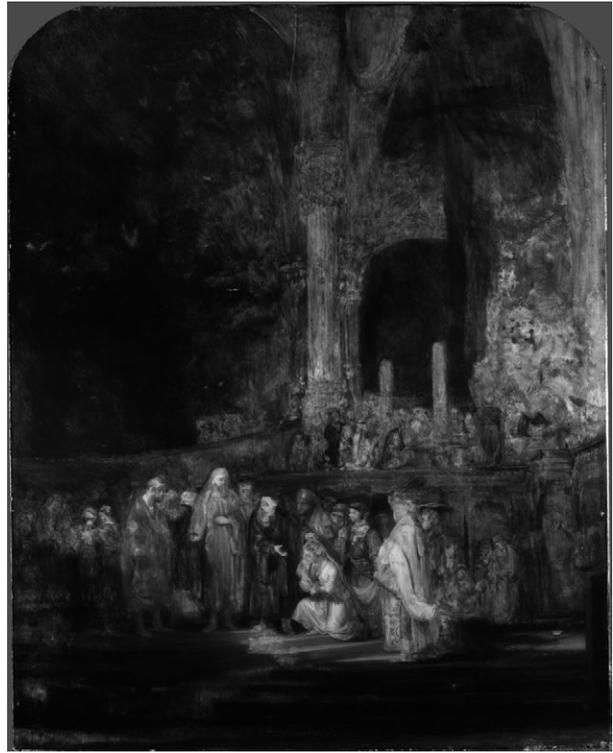


Figure 8 Rembrandt, *The Woman Taken in Adultery*: infrared reflectogram. Photo © The National Gallery, London.

made to the figures. As in the *Woman Bathing*, when Rembrandt worked with thin glaze-like browns he did so with real energy, and the IR reflectogram gives a much better impression of the quality of the brushwork than is possible by simply looking at the paint, which has become rather murky over time (Fig. 8).

Rembrandt made a number of modifications to the main figure group (Fig. 9) which can be seen in the IRR images: because the paint he used absorbs some IR light, different thicknesses show correspondingly as lighter or darker. What IRR can show is paint, including some outlines; the problem is deciding whether these were initial sketches (and therefore underdrawings) or if they were part of Rembrandt's final paint layers since he favoured using dark outlines to define contours.

The *Art in the Making* catalogue entry for this picture states that: 'the main figures are painted thickly and opaquely with only minor adjustments of outline.'⁷ This was determined from careful study of the X-ray images but the IR reflectogram reveals that in reality Rembrandt made numerous changes as he painted these figures, especially to the onlookers gathered around them. Christ himself is perhaps

the least altered, although there are some modifications – the contour of his hair was straightened and extended over background paint, his left arm and shoulder were expanded over the onlooker behind, the left hand was made smaller and the way the drapery looped over his arm was altered. Looking at the accused woman in IR provides some helpful information on Rembrandt's painting technique: large broad brushstrokes can be seen blocking in areas of shadow, for example to the left of the figure's bodice (Fig. 10). Some of these brushstrokes work as part of the finished figure and should probably be understood as underlayers for the finished painting (or admixtures in the surface paint as in the shadows in her dress), but other parts – such as the dark line across the highlight of her breast and the line across her right wrist – must be part of an earlier position for the figure.

The man presenting her has been altered even more radically. In the IRR image his head appears rather ghostly and deformed because Rembrandt has attempted at least two, possibly three, poses, some more fully painted than others. Perhaps the most obvious change is an earlier neckline



Figure 9 Rembrandt, *The Woman Taken in Adultery*: detail of the infrared reflectogram showing the main figure group. Photo © The National Gallery, London.



Figure 10 Rembrandt, *The Woman Taken in Adultery*: detail of the infrared reflectogram showing the accused woman and her accuser. Photo © The National Gallery, London.

painted straight across the small area that is now his beard. His right arm was moved up and his feet are clearly painted over the finished steps, with

the right foot situated over a mysterious patch on the steps. This strange area was identified as ‘the main puzzle of the X-ray’ for the authors of the *Art in the Making* catalogue entry, who associated it with other dark patches in the foreground, possibly a stream of onlookers curving round in front of the main figures.⁸ It did not show at all in the IR photograph, but can clearly be seen in IRR as a light area, which indicates that something has been painted here using a pigment more reflective to IR radiation than the pigments in the ground (but not lead white since it appears dark in X-radiographs). None of the other dark patches seen in the X-ray images behave in this way in IRR but more examination would be needed to find a resolution to this conundrum.

The other figures exhibit the effects of Rembrandt changing his composition as he painted. All appear rather patchy in IRR: some have reserves that do not quite fit the final figures while others are painted directly over architecture or other figures. Where the paint is thinner or less opaque, as in the little group on the right, the IR reflectogram does seem to show broad brush-like lines that could be the remains of an initial outlining stage although we cannot state with confidence that this is a separate underdrawing.



Figure 11 Rembrandt, *The Lamentation over the Dead Christ*, c.1635, oil on paper and canvas on oak, 31.9 × 26.7 cm, The National Gallery, London, NG43. Photo © The National Gallery, London.



Figure 12 Rembrandt, *The Lamentation over the Dead Christ*: infrared reflectogram. Photo © The National Gallery, London.

The Lamentation over the Dead Christ

The third subject, *The Lamentation over the Dead Christ* (NG43) dated c.1635, is a very different type of painting (Fig. 11). Its complex evolution and resulting structure are fully described in the literature.⁹ In summary, the work was started on paper, parts of which were torn away and the remaining paper stuck onto canvas. Two further pieces of canvas were added to expand the painted surface at the top and bottom, and the whole construction was mounted on a small wood panel. The paint is relatively thin, but it is essentially a grisaille therefore the upper paint layers contain a fair amount of black pigment. It was hoped that IRR would provide more information on the changes made by Rembrandt and also perhaps produce an image of what the authors of the *Art in the Making* catalogue entry describe as ‘a lay-in in tones of brown directly on the paper’ made at the first stage.¹⁰

The IRR image was disappointing in this regard (Fig. 12). The paper is not primed in any way and has become a fairly dark, brownish colour, presumably due to absorption of oil and varnish from the front and glue from the back. The darkened paper

therefore does not provide a good contrast to those areas of paper with thin brown paint: the image only shows light areas where thicker lead white-containing paint strongly reflects the IR radiation alongside darker areas where the IR radiation reaches the paper, perhaps because it was left exposed or due to the thinner paint: either way it is not reflected as effectively (Fig. 13a and b). Brown paint – both lines on top and the thin first lay-in – does not show clearly, if at all. For example, the very clear lines of detailing on the sleeve of the woman on the right vanishes completely in the IR reflectogram, and the head of the man behind the Virgin, where dark paint of the lay-in is visible under magnification, becomes indistinct.

However, the IR reflectogram does provide some valuable information (Fig. 14). Some of the *pentimenti* already identified from the X-ray images – such as the tower that was painted in the middle distance and then covered with sky paint – show rather better in IRR. One previously unidentified change can clearly be seen: the good thief was painted on the paper in a lower position, his hands level with the top of his head in its final position – the top edge of the paper is here and the horizontal bar of the cross was just



Figure 13 (a) Rembrandt, *The Lamentation over the Dead Christ*: detail showing the Virgin and surrounding figures and (b) infrared reflectogram. Photos © The National Gallery, London.



Figure 14 Rembrandt, *The Lamentation over the Dead Christ*: detail of the bottom part of the infrared reflectogram. Photo © The National Gallery, London.

below it. This figure was only painted in his present position when another artist decided to expand the composition onto the added canvas. Another observation can be made, this time about the support: where the paint is thinner, laid lines in the paper can be seen, a reminder that such useful features, as well as watermarks, can be revealed by IRR.

Anna and the Blind Tobit

The fourth painting studied is also the earliest, dating from about 1630, when Rembrandt was still in Leiden (Fig. 15). *Anna and the Blind Tobit* (NG4189) is a work the authorship of which has been much debated, having oscillated between Rembrandt and his pupil Gerrit Dou or sometimes regarded as a joint work. It was not included in the *Art in the Making* exhibition since at that time it was attributed to Dou,¹¹ but it has since been reattributed to Rembrandt and therefore gained an entry in the new edition of the catalogue.¹² In 1999 this painting was still attributed to Dou and IRR was carried out using a Hamamatsu vidicon.¹³

The background of the painting is very dark therefore not much can be discerned in IRR, but the figures and foreground produced some very interesting results (Fig. 16). Again it is the paint that is visible in these images rather than a distinct, separate underdrawing; the paint is freely and vigorously applied, with many changes. The most notable alteration in this composition, clearly visible in the X-ray images, is that originally there was a spinning wheel situated between Anna and Tobit. Disappointingly, this is not at all clear in the IR reflectogram: only the thread extending towards Anna can be seen. After comparison with the X-radiograph, the edge of the wheel can just be made out, but this would not have been identified if IRR was the only image available. Elsewhere IRR was more successful in providing information on the evolution of the composition. The artist experimented with different outlines for the window opening and perhaps the inclusion of a large tree; he adjusted the size and shapes of the pots in the foreground still life and there are changes in the figures. None of these modifications was unexpected since most can be found in the X-ray images, but the freedom of brushstrokes in the figure of Anna



Figure 15 Rembrandt, *Anna and the Blind Tobit*, c.1630, oil on oak, 63.7 × 47.7 cm, The National Gallery, London, NG4189. Photo © The National Gallery, London.



Figure 16 Rembrandt, *Anna and the Blind Tobit*: infrared reflectogram. Photo © The National Gallery, London.



Figure 17 Rembrandt, *Anna and the Blind Tobit*: detail of the infrared reflectogram showing Anna. Photo © The National Gallery, London.

in particular is very striking (Fig. 17). Anna’s position and the basket on which she is sitting have been altered. The contour of her back is now fixed by the dark grey surface paint, which unfortunately blocks IR from penetrating further. Many of the dark marks in her skirt are also from the final paint layers, but other brushstrokes visible in the image – especially those across her back and down her arm – originate from an earlier stage in the figure’s development.

Conclusions

Has this limited experiment with IRR been a success? It was a restricted sample group of pictures, but even

though no clear underdrawing was found, there is a great deal that can be learned from the IR images, and the more paintings that are studied using this technique, the more we will be able to understand what we are seeing. Technology continues to improve and several new and exciting techniques have been developed for non-invasive examination of paintings, but it will be some time before methods such as hyperspectral or XRF imaging are widely used. Until then, this work shows that the older techniques still have something valuable to contribute.

Notes and references

1. Bomford, D., Roy, A. and Brown, C. with contributions from Kirby, J. and White, R. (1988), *Art in the Making: Rembrandt*, 1st edn, London, National Gallery Company.
2. Bomford, D., Kirby, J., Roy, A., Rüger, A. and White, R. (2006), *Art in the Making: Rembrandt*, 2nd edn, London, National Gallery Company.
3. *Ibid.*, 140.
4. *Ibid.*, fig. 143.
5. *Ibid.*, 141.
6. *Ibid.*, 142–4.
7. *Ibid.*, 130.
8. *Ibid.*, 131.
9. *Ibid.*, 100–109.
10. *Ibid.*, 105.
11. Maclaren, N., rev. edn. by Brown, C. (1991), *National Gallery Catalogues: The Dutch School 1600–1900*, vol. 1, London, National Gallery Company: 109–12.
12. Bomford *et al.* 2006 (cited in note 2) 62–9.
13. Wadum, J. (2002), ‘Dou doesn’t paint, oh no, he juggles with his brush: Gerrit Dou, a Rembrandtesque “Fijnschilder”’, *ArtMatters: Netherlands Technical Studies in Art 1*: 62–77.

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Rembrandt's *Supper at Emmaus* of 1648: technical observations made after restoration

Bruno Mottin

ABSTRACT The recent cleaning of Rembrandt's *Supper at Emmaus* has significantly modified the appearance of the painting and allowed a new examination of the work whose conclusions differ considerably from that written previously, notably in the *Corpus of Rembrandt Paintings*. The author shows that the paint handling is rougher than was formerly believed, that the painting has not been cut on the left side and was conceived on a square format. In addition, the surface is not as damaged as was previously thought since Rembrandt himself used a knife and a piece of cloth to scrape away the impastos and wipe the glazes.

Introduction

The Supper at Emmaus is a celebrated painting, signed and dated 'Rembrandt fecit 1648', bought in 1777 for King Louis XVI and now in the Musée du Louvre (Paris) (Fig. 1).¹ The subject comes from St Luke's Gospel and depicts the resurrected Christ revealing himself to two of his disciples as he breaks bread.

While it is generally regarded as one of Rembrandt's great masterpieces, Ernst van de Wetering has described how this painting was close to being rejected from the master's oeuvre by the Rembrandt Research Project, largely because the extremely fine technique used was not consistent with the rough handling of the paint usually observed on Rembrandt's works of this period.² The painting was finally published as an original in the fifth volume of the *Corpus of Rembrandt Paintings*³ in which Van de Wetering demonstrated that its high quality and innovative character were specific to the master himself and without equivalent in the production of his followers. But he also noted that the painting was then covered by a thick, dark brown varnish which severely hampered proper appreciation of its high quality.



Figure 1 Rembrandt, *The Supper at Emmaus*, 1648, Paris, Musée du Louvre, inv. no. 739: after restoration. Photo © C2RMF Elsa Lambert.

It is thanks to Blaise Ducos, curator of the Flemish and Dutch Golden Age paintings at the Louvre, that *The Supper at Emmaus* was cleaned in 2010 by the



Figure 2 Rembrandt, *The Supper at Emmaus*: detail showing Christ and the apostles before cleaning. Photo © C2RMF Elsa Lambert.

restorer Isabelle Leegenhoek. The restored painting was one of the revelations of the exhibition *Rembrandt et la figure du Christ (Rembrandt and the Face of Jesus)*, held at the Louvre, the Philadelphia Museum of Art and the Detroit Institute of Arts in 2011–2012.⁴ The cleaning transformed the appearance of the painting so radically that only now are we able to appreciate fully the great subtleties of the colouring and boldness of its making. It also allows us to re-examine more confidently the painting technique and to propose substantial modifications to previously published comments, notably in the fifth and sixth volumes of the *Corpus*.

Earlier restorations

The Supper at Emmaus has only undergone a few restorations – the last major cleaning dates from 1894 and was so vehemently criticised that it probably prevented any fundamental new conservation treatment during the whole of the following century. One of the harsher critics was the painter Edgar Degas, who complained that he was no longer able to perceive the Rembrandt he knew in the cleaned painting: ‘To touch a Rembrandt, does one know what one is touching? Does one know how it is made? It is a mystery. ... I am going to write an article, I will

begin with these words: this is also a bomb!’⁵ A journalist writing in the newspaper *L’Eclair* went so far as to blame the restorer for having removed original paint layers and the final glazes.⁶

Fifty-six years later, in 1950, a new cleaning was judged to be needed, but the restorer, Longa, was asked to restrict it to a partial thinning of the varnish. This seemed to produce satisfactory results immediately since the painting was no longer completely yellow, but the use of strong solvents accelerated the yellowing of the remains of varnish which continued to darken: the painting progressively became a gloomy nocturnal scene in a half-lit tavern.

The recently cleaned painting that we now admire without any restrictions is the painting, paradoxically, that horrified the painter Degas in 1894 as well as journalists. It confirms the extent to which our understanding of Rembrandt’s technique has evolved. The restoration carried out by Isabelle Leegenhoek, under the guidance of an international committee, produced a remarkable metamorphosis of the work. The scene now takes place in a well-lit interior, bathed in full daylight. The figure of Christ is no longer an evanescent ghost, but a living person radiating a deep inner reflection (Figs 2 and 3). The overall colour scheme, previously dominated by yellow varnish, is now a subtle combination of whites, ochres, reds, pinks and mauves. Light plays an essential role that enhances the gesture of Jesus



Figure 3 Rembrandt, *The Supper at Emmaus*: detail showing Christ and the apostles after cleaning. Photo © C2RMF Elsa Lambert.

breaking bread, silhouettes the apostle on the left and accentuates the movement of the apostle at the right, who is pushed forward in contrast to the dark green coat of the servant carrying a tray loaded with a smoking piece of meat, presumably a lamb's head. Examination in raking light demonstrates that the brushwork is not as smooth as once believed: rather it is executed in a predominantly 'rough' technique, frequently based on the juxtaposition of different colours, as in the servant's face, where the pink cheek contrasts with the yellow of his forehead, and in the face of Jesus, where the visibility of individual brushstrokes creates effects of depth that contribute to enlivening his pale and luminous face (Fig. 4).

The original format of the painting

Some unresolved questions can now be re-examined more confidently, one of which concerns the original format of the painting. At present, *The Supper at Emmaus* is an almost square panel measuring 68 × 65 cm, a format which seems to be unique in the whole of Dutch seventeenth-century painting. The figure of Christ is not placed at the centre of the panel but 8 cm to the left of the central axis. This observation led Van de Wetering to suggest that the panel was initially rectangular and that around 16 cm

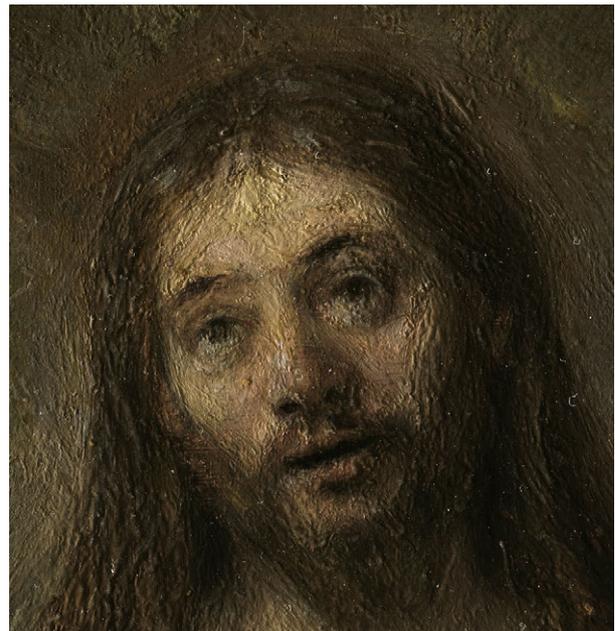


Figure 4 Rembrandt, *The Supper at Emmaus*: detail showing Christ's head in raking light. Photo © C2RMF Elsa Lambert.

has been cut from the left side. This hypothesis was strengthened by the fact that three contemporary paintings, made in Rembrandt's circle and which derive from *The Supper at Emmaus*, are themselves rectangular and place Christ at their centre. A canvas painting, now in Copenhagen (Statens Museum for Kunst), executed by an unidentified pupil of Rembrandt's, also bears the same date as



Figure 5 School of Rembrandt, *The Supper at Emmaus*, Paris, Musée du Louvre, inv. no. 1753. Photo © C2RMF Elsa Lambert.

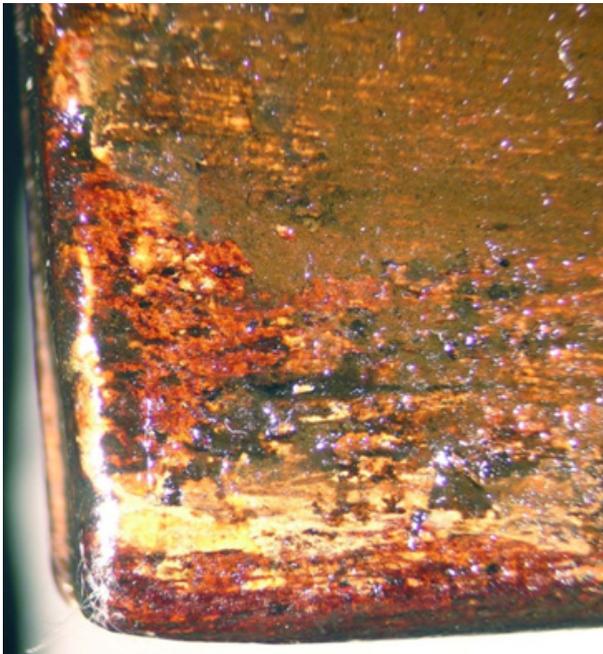


Figure 6 Rembrandt, *The Supper at Emmaus*: detail showing the lower left corner. Photo: © C2RMF Bruno Mottin.

The Supper at Emmaus (1648) and is completed at the left by a curtain.⁷ A second painting in Paris (Musée du Louvre), sometimes attributed to Aert

de Gelder, is dated about 10 years later and features a window on the left (Fig. 5).⁸ A third painting of this subject, now in Rome (Galleria Nazionale d'Arte Antica), signed Gerbrand van Eeckhout and dated 1655, has a similar window on the left.⁹ Even though all these versions seem to have been produced after a rectangular model, we can demonstrate that Rembrandt's panel has not been cut. *The Supper at Emmaus* is painted on a single board of *Swietenia* spp. Meliaceae,¹⁰ a variety of mahogany that grows in southern and central America. Research by Peter Klein and Hubert Olbrich has confirmed that this wood was commonly used in America to make crates for the storage of valuable commodities that were shipped to Europe, such as tobacco leaf and sugar loaves.¹¹ Once they reached Europe, the boards were often sold to painters who appreciated the wood's qualities, the large width of the planks and their low price as recycled timber. Rembrandt and his circle acquired several of these boards for painting, some of which retain traces of their original function, such as the *Rabbi with a Cap*¹² in the British Royal Collection where, until recently, part of a metal handle had been attached to the back. There are no traces of a similar handle on the back

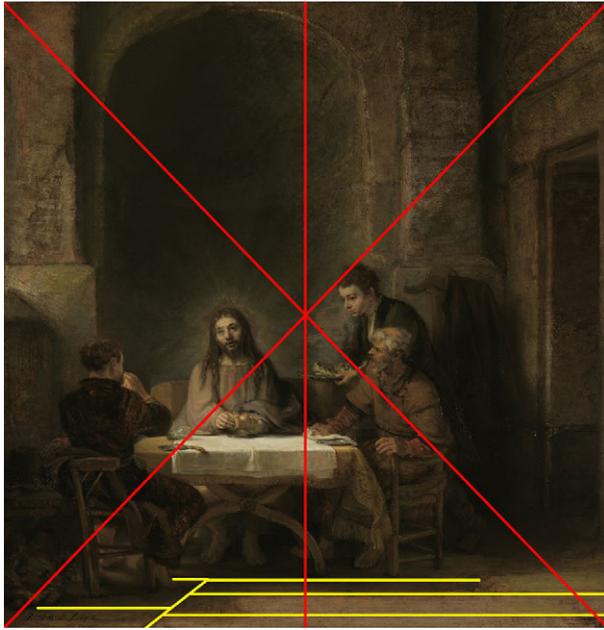


Figure 7 Rembrandt, *The Supper at Emmaus*: the diagonals on the panel are highlighted in red and the perspective lines for the floor in yellow. Photo © C2RMF Bruno Mottin.



Figure 8 Rembrandt, *The Supper at Emmaus*: false-colour infrared image. Photo © C2RMF Elsa Lambert.

of *The Supper at Emmaus*, but three edges of the painted side are bevelled on the left, right and lower sections (Fig. 6). These bevelled edges were made before the board was used for the painting since the ground and the paint layers spread onto them. The upper edge is not bevelled but cut square, perhaps to remove nails or metallic fixings attached to this part of the panel.

An examination of the painting confirmed these conclusions. The scene takes place in a large room with a wooden floor comprising long boards running parallel to the back wall. Perpendicular lines in the floorboards can be used to determine the vanishing point of the painting. Had the scene been centred on the figure of Christ, these lines would have been directed precisely towards him. Instead, however, the vertical lines of the floor run towards the exact centre of the panel, which must therefore be its original uncut size (Fig. 7). The off-centre design arising from the conscious shift of the position of Christ may have troubled Rembrandt's pupils, who then modified their designs in their versions. But Rembrandt himself was very likely interested in the dynamic effect produced by the off-centre placing of the main figure, as explained by Jacques Foucart in 1982: 'if the figure of Christ, seen head on, is placed in the middle of his disciples,

Rembrandt has carefully taken care to shift the central axis of the picture, giving back to the work this sense of reality and movement which characterises all paintings of the Baroque era.'¹³

The paint layers and technique

The panel is coated with a double ground. The first layer, made of chalk probably mixed with animal glue, is covered by a second layer containing chalk, lead white and umber, most likely bound in oil. The upper ground, visible in many parts of the painting, has an irregular uneven surface, suggesting that it was applied with a spatula-like tool that has left a textured surface.

The ground is covered by a thin dark brown imprimatura layer, the presence of which accentuates the irregularities of the surface. Over the imprimatura Rembrandt has brushed in a rapid sketch with the same brown pigments in order to set the positions of the figures. The paint layers are often notably thin: the ground, imprimatura and the sketch are left visible, particularly in the background and in the clothes of the figures, as shown by the false-colour infrared image in which these



Figure 9 Rembrandt, *The Supper at Emmaus*: X-ray image. Photo © C2RMF Elsa Lambert.

areas register as a pinkish colour (Fig. 8). Light and shadow, impasto areas and glazes are carefully balanced to increase depth and volume in the interior space and to concentrate the viewer's attention on the face of Christ.

The X-ray image shows that Rembrandt distributed the highlights rather differently in the first stage of the painting and then modified them in the final image (Fig. 9). Initially, the main impasto strokes were concentrated on the left pilaster, the right part of the apse and the wall in front of the window. The light surrounding the figure of Christ and illuminating the tablecloth would then have seemed rather secondary in its effect compared to the highlights on the architecture. For this reason, Rembrandt evidently decided to tone down the highlights in the background by applying a layer of fluid greenish paint over those layers inside the apse, on the right wall and around the servant's head. This toning down of the highlights was probably not sufficient to alter the balance of light and shade in the picture and may explain why the X-ray image reveals that large parts of the highlights of the background have been scraped away, notably along the left pilaster (Fig. 10a and b), in the region of the apse and around the head of the servant.

These scraped areas have sometimes been regarded as damages, produced either by exposure

to poor conditions or by abrasion of original paint during a past cleaning. The strange appearance of the architectural interior was probably responsible for the criticisms made at the end of the nineteenth century, and also perplexed the authors of the *Corpus* who considered this part of the painting to be severely damaged. In fact, most of the scraping seems to have been made by Rembrandt himself using a palette knife, except for some accidental losses along the edges. The marks made by the palette knife are clearly visible on the edge of the table, where Rembrandt thinned the white impasto mechanically to render the cloth in shadow (Fig. 11). Several incised lines in the white layer left by the tool are partly covered by creamy vertical brushstrokes applied by Rembrandt to suggest the folds of the cloth. The palette knife was also used to inscribe the vertical line separating the left pedestal from the pilaster above. Over the vertical line, the whole pilaster is affected by losses resembling damages. These losses have a very irregular form, however, with no signs of a craquelure pattern which would normally have formed before any flaking occurred or before an aggressive cleaning process. The paint has the appearance of a partially thinned surface where some highlights have been left, as in the lower part of the pilaster, and some have been totally scraped off, most notably in the upper part. The losses in the paint surface do not reveal the wood of the panel but a brown layer painted over the ground. In addition, they do not alter the general state of the painting, suggesting more the look of a decaying building. Moreover, this removal of paint has not affected the fragile parts of the painting, for example the brown translucent layers, but only the lead white-based impasto areas that are usually solid and robust. If excessive cleaning had abraded these parts, it would have produced major damages in the dark tones but this is not what we observe. In this context, a significant observation was made by the restorer of the painting, Isabelle Leegenhoek, who noticed that many losses are covered by the same greenish paint layer that is present on undisputed parts of the painting. This demonstrates that Rembrandt himself scraped the painting and reworked it in an unusual, but creative, combination of the addition and subtraction of his paint layers.

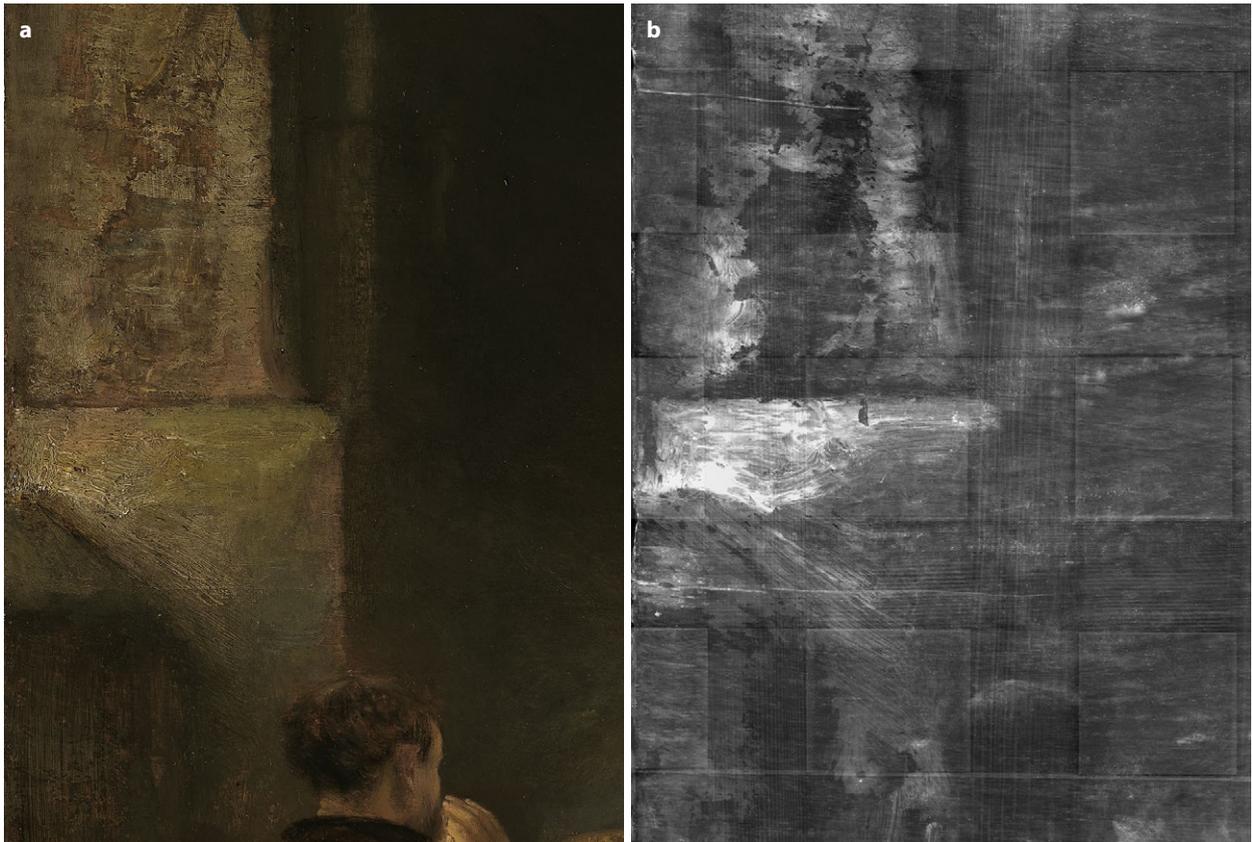


Figure 10 (a) Rembrandt, *The Supper at Emmaus*: detail showing the pilaster on the left and (b) X-ray image. Photos © C2RMF Elsa Lambert.

The depiction of smoke in the painting

At the right, a servant carries a tray loaded with a dish containing a lamb's head smoking from the oven. The smoke is not actually painted but is suggested by thinning the upper greenish layer which lies over a pinkish-brown underlayer. The irregular contour of this thinned area suggests that it was made by dabbing with a piece of cloth or with a dry brush. This surprising way of representing smoke has puzzled several commentators who have speculated that the greenish layer had been badly damaged by a restorer who removed the white opalescent layer of the smoke.

The recent cleaning of the picture, however, demonstrates that the rendering of the smoke remains as perfect as when it was first created: a white layer is not needed to suggest its presence. The technique used is most effective and the viewer can almost feel the smoky vapour over the tray and along the right shoulder of the servant, which is convincingly blurred by its presence (Fig. 12). The deployment of such a bold effect is typical of a great master who understands that it may be more effective to subtract



Figure 11 Rembrandt, *The Supper at Emmaus*: detail of the tablecloth showing the use of a palette knife. Photo © C2RMF Bruno Mottin.

layers instead of just adding them. It is also characteristic of a painter familiar with the technique of etching, where it is standard practice to add or erase forms during the creative process.

We conclude, therefore, that Rembrandt's *Supper at Emmaus* is a much less damaged painting than

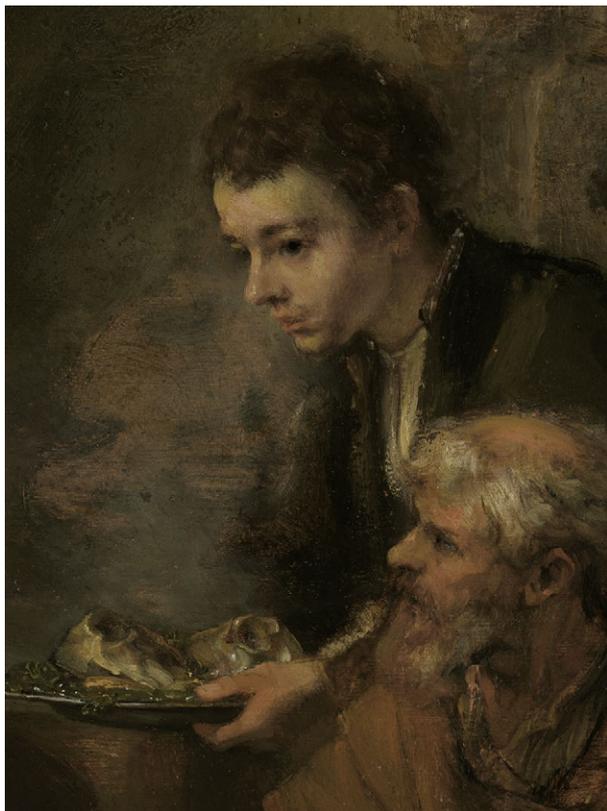


Figure 12 Rembrandt, *The Supper at Emmaus*: detail showing the servant and his tray. Photo © C2RMF Elsa Lambert.

previously thought: the panel is not cut and the paint surface is not badly damaged. This great masterpiece has proved a spectacular revelation, even to those specialists who know it well, after this long anticipated and most successful cleaning.

Notes and references

1. This article expands on two texts previously published in a C2RMF *Technè* bulletin entirely dedicated to Rembrandt; Curie, P. and Leegenhoek, I. (2012), 'Les Pèlerins d'Emmaüs de Rembrandt: une restauration très attendue', *Technè* 35: 66–71; Mottin, B., Eveno, M. and Laval, E. (2012), 'L'étude de laboratoire des Pèlerins d'Emmaüs (1648)', *Technè* 35: 72–7.
2. Van de Wetering, E. (2014), 'What is a Rembrandt?: a personal account', in *A Corpus of Rembrandt Paintings VI. Rembrandt's Paintings Revisited: A Complete Survey*, Dordrecht, Springer: 38.
3. Van de Wetering, E. (2011), *A Corpus of Rembrandt Paintings V. Small-Scale History Paintings*, Dordrecht, Springer: 465–78.

4. Dewitt, L., Ducos, B. and Keyes, G.S. (2011), *Rembrandt et la figure du Christ (Rembrandt and the Face of Jesus)*, exh. cat., Paris, Musée du Louvre/Philadelphia, Philadelphia Museum of Art/ Detroit, Detroit Institute of Arts.
5. 'Toucher à un Rembrandt, sait-on ce qu'on touche? Sait-on comment c'est fait? C'est un mystère. [...] Je vais écrire un article, je commencerai par ces mots: ceci est aussi une bombe'; Halévy, D. 1960 (1995), *Degas parle*, Paris, La Palatine, reprinted Paris, Editions de Fallois: 53–4.
6. Anon., *L'Eclair*, 1 June 1894.
7. Pupil of Rembrandt, *The Supper at Emmaus*, 1648, oil on canvas, 875 × 111 cm, Copenhagen, Statens Museum for Kunst (see Van de Wetering 2011 [cited in note 3] cat. V 15: 479–88).
8. Unknown painter, *The Supper at Emmaus*, oil on canvas, transferred from canvas, 50.3 × 63.8 cm, Paris, Musée du Louvre (see Van de Wetering 2011 [cited in note 3] cat. V 16: 489–94).
9. Gerbrand van den Eeckout, *The Supper at Emmaus*, 1655, Rome, Galleria Nazionale d'Arte Antica.
10. The wood identification was made by Catherine Lavier, CNRS, Paris.
11. Klein, P. (1988), 'Hat Rembrandt auf Zuckerkistenholz gemalt?', *Zuckerhistorischen Beiträge aus der Alten und Neuen Welt, Schriften aus dem Zucker-Museum* 25: 37–43.
12. Rembrandt, *A Rabbi with a Cap*, also called *Bust of a Bearded Old Man in a Fanciful Costume*, Hampton Court, Royal Collections, published as 'School of Rembrandt' in Bruyn, J., Haak, B., Levie, S.H., Van Thiel, P.J.J. and Van de Wetering, E. (1989), *A Corpus of Rembrandt Paintings III*, Dordrecht/Boston/London, Martinus Nijhoff Publishers: 646–50. It is considered as an original by the master in the sixth volume: Van de Wetering 2014 (cited in note 2) 233 and 552.
13. 'si le Christ, vu de face, est placé au milieu de ses disciples, Rembrandt a soigneusement pris soin de le décaler de l'axe central du tableau, redonnant à l'oeuvre ce sens de la réalité et du mouvement qui qualifie toute peinture d'âge baroque': Foucart, J. (1982), *Les peintures de Rembrandt au Louvre*, Paris, Réunion des Musées Nationaux: 53.

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In search of Rembrandt's underdrawing

Jørgen Wadum

ABSTRACT Since the initiation of the Rembrandt Research Project in the late 1960s, technical study of Rembrandt's paintings has gained increasing importance in the understanding of his working methods. Examining the artist's works with dendrochronology, X-radiography and macro photography became the norm complemented by cross-sections of ground and paint layers as well as scientific analysis of binding media and pigments. Significant advances were made in understanding the materials and properties of the master's use of and experimentation with supports and mediums. However, although some infrared photographs were taken, examination of early Rembrandt paintings using infrared reflectography (IRR) was not employed until the astonishing 1998 discovery of an extensive underdrawing below the paint layers of the painting once considered to be a cornerstone of Rembrandt's early works: the *Young Self-Portrait with a Gorget* from c.1629 in the Mauritshuis (The Hague). This discovery prompted the author to undertake a limited survey into a selection of early paintings by Rembrandt and his close circle that revealed a wealth of hitherto unrecorded information acquired from beneath the visible paint layers of the paintings. This paper demonstrates the relevance of the IRR technique in the discovery not only of underdrawings but also how underpaintings and sketches can be visualised. Instigating a comprehensive search for Rembrandt's underdrawing – in the widest sense of the word – in his early works may add significant new information to the corpus of the artist and his contemporaries.

Introduction

The Rembrandt Research Project (RRP), established in the Netherlands, commenced its research in 1968. The final and sixth volume in the series produced as an outcome from this research, *A Corpus of Rembrandt Paintings VI. Rembrandt's Paintings Revisited: A Complete Survey*, was published in 2014.¹ The completion of such a large corpus of documentary evidence (over 4600 pages) on a single artist, his techniques and painterly approaches constitutes a unique resource for scholarly research. This wide-ranging work offers detailed narratives on each painting illustrated with black and white images and, later on, colour photographs, accompanied by abundant technical observations and images. This vast collection of information on Rembrandt's paintings has engendered much debate in the scholarly community and new interpretations of the results

will surely continue in the future as scholarship progresses. Importantly, considerations as to what might be accomplished in the future to complement and test the results obtained by the RRP will certainly be pursued using new ways of looking at the subject and the application of more up-to-date technologies. At the same time, scrutiny of Rembrandt's paintings will continue to yield new information on his individual painterly methods and habits. However, only by an equally close examination of the work of Rembrandt's circle can the differences or similarities in technique and painterly approach be fully evaluated and eventually the distinction of one painter over another more clearly understood.

Rembrandt was a successful and popular teacher with more than 50 documented students, all of whom he would have taught to draw in his style.² Between them they produced thousands of drawings and it is understandable that even early on

Table 1 The occurrence of references to IR photography compared with IRR in the individual volumes of *A Corpus of Rembrandt Paintings*.

<i>Corpus</i> volume	IR photo	IRR	Year of publication
I	41	1	1982
II	35	4	1986
III	44	3	1989
IV	46	30	2005
V	57	29	2011
VI	13*	16*	2014

* The count refers to the chapter entitled 'Notes to the Plates', pp. 480–687

there was confusion as to their authorship. This is particularly true of Ferdinand Bol, who worked in a Rembrandtesque style during the 1640s and could emulate the master's 'handwriting' and shorthand drawing style most convincingly when sketching on paper with ink and brush.³ While recognising Rembrandt's mastery in drawing and etching, the study of his 'ductus' will continue to occupy scholars as will the search to examine and record the very first brushstrokes – some of which may be defined as underdrawing – that Rembrandt may have applied to an otherwise completely empty and blank, untouched primed panel or canvas.

Rembrandt and infrared imaging research from 1982 to 2014

It had long been assumed that it was unlikely that Rembrandt began a painting by first making a compositional drawing to serve as a guide for the successive paint applications that would finally cover the drawing completely. This procedure was, however, considered standard practice among painters and therefore common in both the earlier generation of artists and among many of Rembrandt's contemporaries. The compilers of treatises on painting techniques such as Karel van Mander,⁴ Sir Theodore Turquet de Mayerne⁵ and later Rembrandt's pupil Samuel van Hoogstraten (1627–1678)⁶ and his pupil Arnold van Houbraken (1660–1719) all discuss the central importance of drawing.⁷ It is surely the case

that most painters who had been taught that drawing is '*den Vader van t'schilderen*' (the progenitor of painting)⁸ would approach the empty primed canvas or panel with a piece of charcoal, an oil crayon, pencil, stylus or simply a pointed brush in order to set down the first ideas of the composition. We now regard a compositional drawing made in one of these media or the initial design achieved during the act of painting and covered by overlying layers as an 'underdrawing'. This preliminary 'drawing', whether in a dry or liquid medium, can be made visible under certain circumstances and recorded by an imaging instrument operating in the 'invisible' near infrared spectrum. Infrared (IR) photography using film was in use as early as the 1950s for the examination of so-called Early Netherlandish paintings, but in the 1960s the technique was greatly improved by the research of J.R.J. van Asperen de Boer from 1968,⁹ who elaborated the work later in his thesis: *Infrared Reflectography: A Contribution to the Examination of Earlier European Paintings*. From 1970, use of the newer IR examination technique dramatically improved the study of paintings.¹⁰ Van Asperen de Boer employed an IR vidicon system sensitive up to a wavelength of 2000 nm and therefore more capable of penetrating the paint than IR photography, which recorded radiation in the wavelength range of approximately 700–900 nm. Despite this ground-breaking work and the fact that infrared reflectography (IRR) could often be employed to investigate whether or not the use of an underdrawing was part of a painter's practice, the IRR technique was not employed by the RRP research team. While it became common for paintings by artists from the fourteenth to the sixteenth century to be documented using IRR, with very revealing results, it was not used to examine the work of artists such as Rembrandt and his circle until many decades later.

The preface to the first volume of the *Corpus* (1982) includes the statement that IR photographs are a good deal less informative than X-radiographs. It was acknowledged, however, that IR photographs occasionally 'throw light in a surprising way on how paint was applied, but where the preparatory stage of the painting process is concerned the absence of any underlying drawing in an absorbent material (like that used by the Early Netherlandish painters) means that in Rembrandt's case infrared photographs do not leave us much the wiser'.¹¹



Figure 1 (a) Rembrandt (studio copy), *Portrait of Rembrandt (1606–1669) with a Gorget*, after c.1629, oil on panel, 37.9 × 28.920 cm, Mauritshuis, The Hague, inv. no. 148. (b) Computer montage of the infrared reflectogram of the painting. Photo courtesy of A. Verburg/RKD.

A tally of the use of IR photography compared to IR reflectography and reflectograms reveals an interesting trend in which references to IR photography remain fairly stable over the years, with an average of 45 references per volume, while IRR documents show a tendency to increase (Table 1).

Although IRR is cited up to four times in Volumes I–III, Volumes IV–V show an abrupt increase to around 30 references per volume.¹² Although still not referred to as frequently as IR photography, in Volume IV from 2005, which appeared 35 years after Van Asperen de Boer first demonstrated and established IRR, there is a significant rise in references to IRR as a tool for examining Rembrandt's work. It is only by Volume VI of the *Corpus* that the use of IRR just about outweighs IR photography as a means of investigation. There is some ambiguity as to the definition of the term in the texts, confirmed by the fact that the term 'infrared reflectography/reflectogram' does not appear in the Glossary of Volume VI, the final work in the series. In this volume, the method of examination in the near IR is referred to by the statement: '*pentimenti* and underdrawing

containing black show particularly clearly in an infrared photograph'.¹³

Rembrandt and underdrawing

The first volume of the *Corpus* quotes Hubert von Sonnenburg's conclusions from his 1969 survey of the state of knowledge on technical aspects of Rembrandt's paintings, maintaining that nothing is known either from sources or examination of any kind about underdrawing used by Rembrandt on his primed panels or canvases. The *Corpus* authors note that Von Sonnenburg then suggested, on the basis of the painting materials and tools depicted in Aert de Gelder's *Self-Portrait as Zeuxis* (Frankfurt, Städel Museum) dating from 1685, that de Gelder (and therefore, perhaps, also his teacher Rembrandt) used white chalk to lay-in the composition on his coloured ground.¹⁴ They remarked, however, that even if Rembrandt employed white chalk for preliminary sketching on the relatively dark grounds he used in his later work, doing so on the lighter grounds of his

early panels would not make sense from a practical point of view. But, as they mention, ‘no trace has been found in Rembrandt’s Leiden panels of a dark underdrawing of the kind that can be seen not only in Rubens’ paintings on panels with a light ground, but also in at least one Lastman painting,’ the latter having been examined by IRR.¹⁵

In the first volume of the *Corpus*, the authors state that they concur with the speculation made by the art historian and restorer Johannes (Hans) Hell (1897–1974),¹⁶ summarising his hypothesis as follows: ‘Rembrandt would have done as a rule his first lay-in with a brush, using brown paint of greater or lesser translucency, not only for drawing lines but also for applying a tone over largish areas (in the way a wash drawing is done).’ In agreement with Hell’s conclusions, their own observations were that ‘So far as the eye can tell, they [the underdrawing and tonal layers] invariably lie directly over the light ground.’¹⁷ The statement was published in 1982 and the two succeeding volumes of the *Corpus* from 1986 and 1989 build on this assumption. It can be imagined, therefore, that it came as a considerable surprise to the world of Rembrandt scholarship in 1998 when it was discovered that below the paint of what was then considered to be a self-portrait by Rembrandt, *Portrait of Rembrandt with a Gorget* after 1629 (The Hague, Mauritshuis, inv. no. 148), was a very detailed underdrawing, made visible with a CCD camera operating in the near IR region (Fig. 1).¹⁸

The introduction of IRR to Rembrandt research

The discovery of an underdrawing below the smooth paint surface of the Mauritshuis painting prompted an urgent comparison and physical confrontation with the early self-portrait in Nuremberg (Germanisches Nationalmuseum), which were placed side by side for the first time and the results of the assessment published subsequently in *Oud Holland* in 2000 (Fig. 2).¹⁹ This direct comparison resulted in serious doubts as to the authenticity of the Mauritshuis work (now labelled ‘Rembrandt van Rijn (studio copy), *Portrait of Rembrandt (1606–1669) with a Gorget*, after c. 1629’) because the notion of an underdrawing was thought to be completely inconsistent with

Rembrandt’s working method. It should be noted that earlier, the German art historian Claus Grimm had questioned the chronology of the two paintings also based on close examination and X-radiograph images of each work.²⁰

The care and detail with which the facial features were drawn in the Mauritshuis *Portrait of Rembrandt with a Gorget* recalls the long-established assessment of the act of drawing as being ‘den Vader van t’schilderen.’²¹ For centuries, apprentice painters had been required to practise drawing faces, hands, feet and draperies, sometimes for years, before graduating to painting,²² whether they were working in Italy, Germany or the Netherlands.²³ These drawings were often made on erasable *tavolette*,²⁴ therefore the great majority would have been lost. This makes it difficult to identify any established artist through his early development as a draughtsman. Van Mander stressed in his *Schilderboeck* that only the most skilled artists could apply a ‘dead-colouring’ directly to the support without any indication of an initial composition. The more inexperienced painter would have to invest much time sketching the scene painstakingly in charcoal and then drawing the outlines in meticulous detail with silverpoint before starting to paint.²⁵ With the discovery of the underdrawing in the Mauritshuis *Portrait of Rembrandt with a Gorget*, which must have been executed in Rembrandt’s studio, the notion must be considered of drawing, making cartoons and transferring these to the panel or canvas before wetting a brush in oil paint.

In the later 1990s, prompted by the detection of the underdrawing in the *Portrait of Rembrandt with a Gorget*, the present author began examining a number of early Rembrandt paintings systematically using IRR analysis for the first time. This project also included paintings formerly attributed to Rembrandt and works by Jan Lievens, Gerrit Dou and Isaac de Jouderville – 59 works in total.²⁶ Although very little underdrawing in a dry medium was detected during this project, a more important finding was that Rembrandt’s virtuoso application and use of an undermodelling in paint – as described by Hell above – can actually be detected in the IRR image. By this means we had gained a completely new source of significant information on the initial application of paint. IRR analysis also revealed that the shaded parts of the face in Rembrandt ‘heads’ from 1626

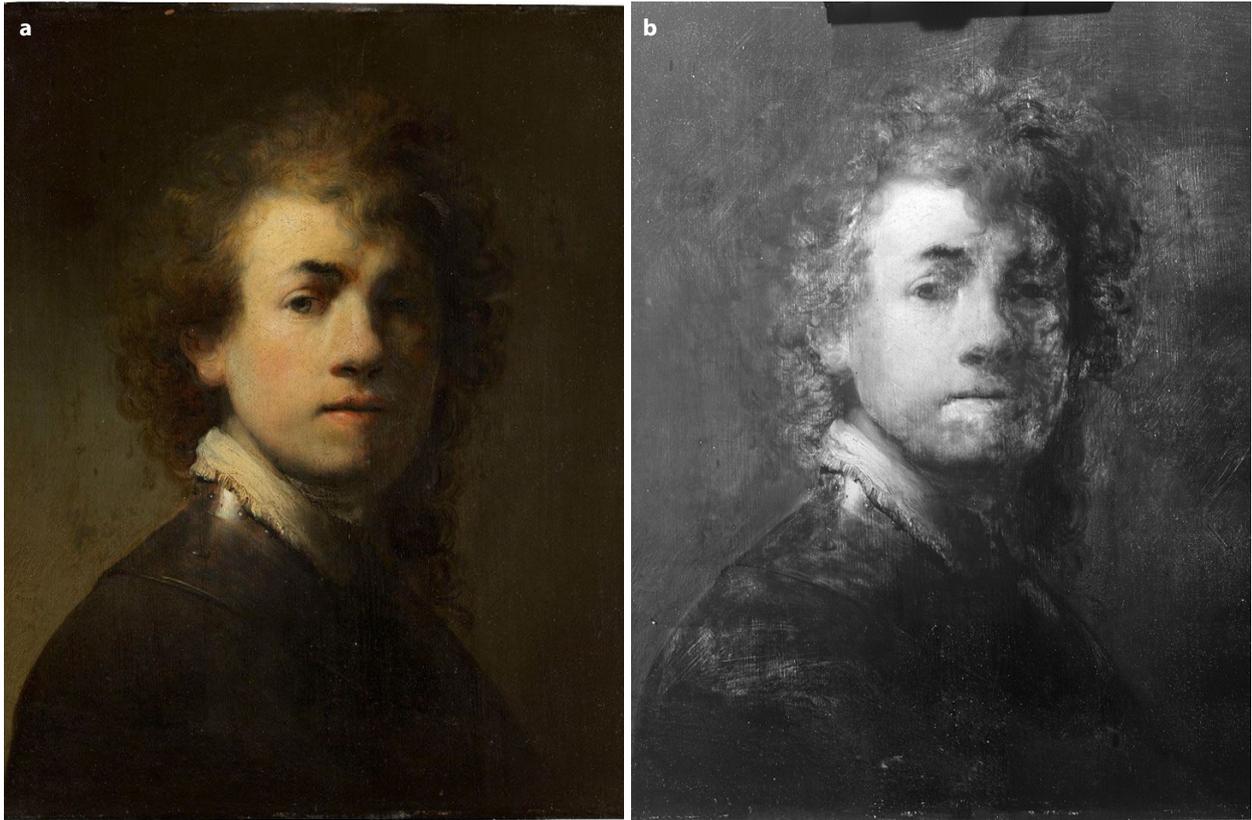


Figure 2 (a) Rembrandt, *Self-Portrait with Gorget*, 1629, oil on panel, 38.2 × 31 cm. Germanisches Nationalmuseum, Nuremberg, inv. no. Gm391. (b) Computer montage of the infrared reflectogram of the painting. Photo courtesy of A. Verburg/RKD.

to 1634 (the main period of this first study) have a characteristic patchy appearance. Since this feature is absent from portraits painted by Lievens, Dou, De Jouderville and other artists close to Rembrandt, we believe that we have uncovered an important marker for the identification of Rembrandt's autograph painting technique, that is, a characteristic that enables us to distinguish Rembrandt's method from that of his early contemporaries.

IR photography for the study of paintings is now largely obsolete having been replaced by the more advanced techniques of CCD imaging and cameras using InGaAs array sensors. In recent decades, these have also demonstrated their importance for the general study of seventeenth–nineteenth-century paintings.²⁷ However, it is the potential for documenting seventeenth-century paintings by Rembrandt and his circle that has yet to be fully appreciated through a structured compilation of comparable documentation by IR imaging which will be made available through, for example, the RKD's growing online Rembrandt Database.²⁸ The possibilities of visualising the initial stages of

Rembrandt's painting process become extremely interesting. The artist would start by delineating the composition in lines of varying thickness directly over the coloured oil ground followed by the application of dead colouring or more extensive undermodelling in monochrome hues ranging from dark (reddish) brown to light ochre hues. Certain areas would be more heavily toned and even some impasto applied; others would be semi-transparent, allowing the lighter ground to shine through. Rembrandt's *Concord of the State* (Rotterdam, Museum Boijmans Van Beuningen), c.1637 (Fig. 3), although made for a different purpose, gives us an impression of an early stage in the painting process before the application of the final paint layers.²⁹ In the earlier *Anatomy Lesson of Dr Nicolaes Tulp*, dated 1632 (The Hague, Mauritshuis), cross-sectional analysis confirmed that Rembrandt applied a brown painted undermodelling at a preliminary stage to define the main form and principal shadows (Fig. 4).³⁰ Scientific analysis has revealed that at this initial stage Rembrandt was probably working with paint bound in an aqueous medium.³¹



Figure 3 Rembrandt, *The Concord of the State*, c.1637, oil on panel, 74.6 × 101 cm, Museum Boijmans Van Beuningen, Rotterdam, acc. no. 1717.

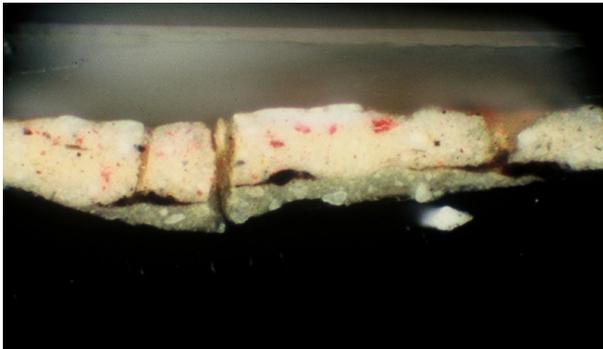


Figure 4 Rembrandt, *The Anatomy Lesson of Dr Nicolaes Tulp*, 1632, oil on canvas, 169.5 × 216.5 cm, Mauritshuis, The Hague. Paint cross-section: at the left can be seen the bright uppermost paint layers of the flesh colour of one of the faces. Below them are pockets of brown paint from the initial painted sketch of the face applied directly over the greyish second ground layer containing lumps of lead white. Missing at the right is the first ground layer in a warm reddish earth colour and the canvas support.

Besides sporadic references in painters' manuals to aqueous 'drawing' media, this would also seem logical: an initial paint layer in such a medium would dry

fairly quickly, enabling the artist to continue in oil without wasting time waiting for an initial oil layer to dry.³² But the use of an aqueous undermodelling has another implication that seems particularly significant to our interpretation of Rembrandt's works: as soon as the aqueous layer was dry, oil paint could be applied directly without 'erasing' the brushstrokes of patchy brownish undermodelling. Therefore the artist could apply oil paint and rework the image wet-in-wet directly on the surface without obliterating his 'composition' beneath and, as significant, without contaminating successive paint by the brownish undermodelling that was now dry. This further explains why IRR reveals the undermodelling so clearly.

IRR examination offers a new means of appreciating Rembrandt's artistic idiosyncrasies and working habits such as, for example, his manner of recording the bluish hue of the white in a sitter's eye. It was appreciated by painters that white paint with a small admixture of vine black provides exactly



Figure 5 (a) Rembrandt, *Portrait of Haesje Jacobsdr van Cleyburg*, 1634, oil on panel, 68.6 × 53.4 cm, Rijksmuseum, Amsterdam, inv. no. SK-A-4833; (b) detail and (c) infrared reflectogram of (b). Photo courtesy of A. Verburg/RKD.

this naturalistic bluish haze in the human eye and this technique has been recorded many times in Rembrandt's portraits and 'tronies' of the 1630s. One example can be seen in the *Portrait of Haesje Jacobsdr van Cleyburg* 1634 (Amsterdam, Rijksmuseum) in which the white of the sitter's eyes show up as dark in IRR due to the incorporation of black pigment with the lead white (Fig. 5).³³ To a lesser degree the same applies to Rembrandt's *Young Woman in Fantasy Costume* 1633 (Amsterdam, Rijksmuseum)³⁴ as well as in his *Self-Portrait with a Velvet Beret and Gold Chain* 1633–36 (Berlin, Gemäldegalerie, Staatliche Museen zu Berlin).³⁵

As indicated above, at the turn of the twentieth century the RRP introduced examination using IRR images in their evaluations, and in Volume V of the *Corpus* (2011) the interpretation of an IRR image was crucial in providing evidence for the reattribution of the *Parable of the Labourers in the Vineyard* 1637 (St Petersburg, State Hermitage Museum). The painting was reattributed to a work by Rembrandt for several reasons, among which were that certain details are much more clearly seen in the IR reflectograms than

in the painting in its present condition.³⁶ It was noted that the details lie on the painted surface of the picture and should not therefore be regarded as possible underdrawings. However, the characteristic way these details are drawn, especially in the group of the four labourers, suggests Rembrandt's own hand. The IRR image demonstrates his careful description of detail and is comparable to his etchings from the same period, which exhibit a similar style of closely observed draughtsmanship.³⁷

Rembrandt's method corresponds to Van Mander's description of bold and inventive painters who 'without great trouble would work directly with brush and paint in a free approach and thus set down their paintings deftly in the dead-colour; they sometimes "re-dead-colour" soon after, so as to achieve a better composition. Thus those who are abundantly inventive go audaciously to work, thereafter making an improvement here and there.'³⁸ We have established that IRR reveals very effectively the mottled, patchy undermodelling or dead and 're-dead' colour' that was commonly used below the paint application of Rembrandt's paintings.



Figure 6 (a) Carel Fabritius, *Hagar and the Angel*, c.1645, oil on canvas, 157.5 × 136 cm, The Leiden Collection, New York; (b) IRR detail of the angel's head and halo, centre right; (c) IRR detail of Hagar's foot, bottom right. Photos (b) and (c): Jørgen Wadum.

Rembrandt's pupils as exemplars of technique

As well as defining Rembrandt's technique, a survey of his pupils' works with IRR imaging may reveal how the master's methods were emulated by his followers, and the way in which his teaching and practice would have found its way into their painting vocabulary when faced with the task of creating a picture. As an example, *The Toilet of Bathsheba* 1643 (New York, The Metropolitan Museum of Art) by one of his pupil's (with intervention by Rembrandt himself) is recorded as showing underdrawing using a brush near the edge of the cliff face when viewed using IRR.³⁹ While the pupil's name is not known for certain, IRR examination of a large number of paintings by Gerrit Dou, Rembrandt's first pupil for almost four years, revealed an extensive use of underdrawing and undermodelling.⁴⁰ The use of underdrawings in works by Dou is more the rule than the exception. During the next stage he would lay down broad brushstrokes of a semi-translucent undermodelling in brown tones, resembling Rembrandt's style, which

he must have adopted while working in his master's studio. The surface film (i.e. the visible paint layer) by contrast reveals only Dou's preference for highly wrought detail and the rendering of idealised images that are almost super-naturalistic compared to the rough paint application of Rembrandt and that of many of his followers.

Carel Fabritius worked briefly in Rembrandt's studio between 1642 and 1643 and some of his early ambitious history pieces – such as *The Raising of Lazarus* c.1643–45 (Warsaw, Muzeum Narodowe in Warszawie)⁴¹ and *Hagar and the Angel* c.1645 (New York, The Leiden Collection)⁴² – exhibit blunt and rough brushstrokes.⁴³ Recent literature suggests that the sparsely populated Middenbeemster, where Fabritius is recorded in 1643, would not have afforded him sufficient clientele, and it is probable that Fabritius travelled back and forth to Amsterdam periodically until 1650.⁴⁴ Some years ago Werner Sumowski (1931–2015) recognised Fabritius' style as 'alternating between the Rembrandtesque and his own manner'.⁴⁵ Indeed, Fabritius could be said to be indebted to his master in his earliest paintings,

however, fairly early on he developed his own unique and characteristic style of brushwork. A stylised handling of the brush, combined with a certain rapid linear as well as rounded dabbing of the paint, begins to occur regularly in his paintings from early on in the artist's development. We might ask whether, like Rembrandt, Fabritius started out on his oil grounds by setting down the composition in darker and lighter lines, followed by the application of the dead colouring (undermodelling) in monochrome brownish hues.⁴⁶ As noted earlier with the aid of IRR imaging of a selection of paintings by Rembrandt and Gerrit Dou, a highly individual and somewhat Rembrandtesque lay-in was discovered in the undermodelling. Similarly, using IRR, the characteristics of Fabritius' brushwork in the initial stages of his painting process was researched and again 'invisible' underlying brushwork was found that set the scene for his compositions. In *Hagar and the Angel* (Fig. 6a) the large halo of the angel in IR reveals blunt broad semicircular lines applied sketchily with a round-tipped brush (Fig. 6b). Below Hagar's left foot we encounter fascinating curly lines forming the contours for the large coiled leaves of the butterbur plant. However, most characteristic are the bluntly applied indications of form around Hagar's left foot (Fig. 6c). The dark brushed lines were applied with vigour and yet the brush was skipping over the canvas before the final paint layers covered these underlying features – only to be revealed once more by IRR imaging.

Discussion

Rembrandt's early apprentices Dou and Fabritius sketched their compositions with charcoal, pencil or a pointed brush on the primed wood panel or canvas. Rembrandt's teacher Pieter Lastman also adopted this technique, which calls to mind the observation by J. Müller-Hofstede and P. Schatborn that some of Rembrandt's drawn compositions were apparently first designed on paper as thin contour lines, and that the next step was to apply a wash using the brush in order to create shape and volume in the scene.⁴⁷ In the very elaborate yet sketchy painting *The Concord of the State* (Fig. 3), the composition was first indicated by faint drawn lines. These lines, however, are painted alternately with lighter or darker paint and

therefore differ from an underdrawing executed in a drawing material such as black chalk for example. During the investigation of Rembrandt's *Andromeda* (The Hague, Mauritshuis), painted c.1630,⁴⁸ IRR examination revealed thin curved lines probably made using a pencil (Fig. 7). Apparently just a few thin lines position the figure directly on the white ground of the wood panel. Does this underdrawn sketch indicate that Rembrandt also occasionally devised his composition with a few drawn lines emulating the way he may have taught his pupils?

Until now this small early work from Rembrandt's Leiden period seems to be accompanied by another two in which a sketchy underdrawing has been detected. An example of this practice is perhaps to be found in the contours of the iris in the sitter's eyes as well as in the left eyebrow in Rembrandt's *Half-length Portrait of a Woman with a Beret* (formerly identified as Saskia) 1643 (Berlin, Gemäldegalerie, Staatliche Museen zu Berlin), which seems to be drawn prior to painting (Fig. 8).⁴⁹ Furthermore, in Rembrandt's *Self-Portrait* of 1658 (New York, The Frick Collection), Volume IV of the *Corpus* mentions having identified lines that: 'If they are lines, they might be shading, which could indicate a type of underdrawing not previously encountered in paintings by Rembrandt.'⁵⁰ In 2021 a long-lost Rembrandt painting was found in Italy depicting the *Adoration of the Magi*.⁵¹ However, the extensive and very detailed underdrawing documented in this painting, which is thought to be the original version, when compared to other versions of this composition, is entirely alien to Rembrandt's working practice. It should be noted that the St Petersburg painting of the *Adoration of the Magi* has, since 2011, been fully reinstalled in Rembrandt's oeuvre as the prototype, something that should have eliminated any further speculation on a 'lost original' by Rembrandt.⁵²

Based on our IRR research, we have demonstrated that the young Rembrandt was already adept at using locally applied brown undermodelling to suggest depth in his compositions. The brown layer applied transparently over an off-white, yellowish ground often produces a warm, reddish glow simulating the reflection of light from an illuminated area adjacent to one in shadow. It is now apparent that IRR also provides information on the build-up of paint layers thereby increasing the imaging technique's power to reveal the genesis of paintings. The less commonly

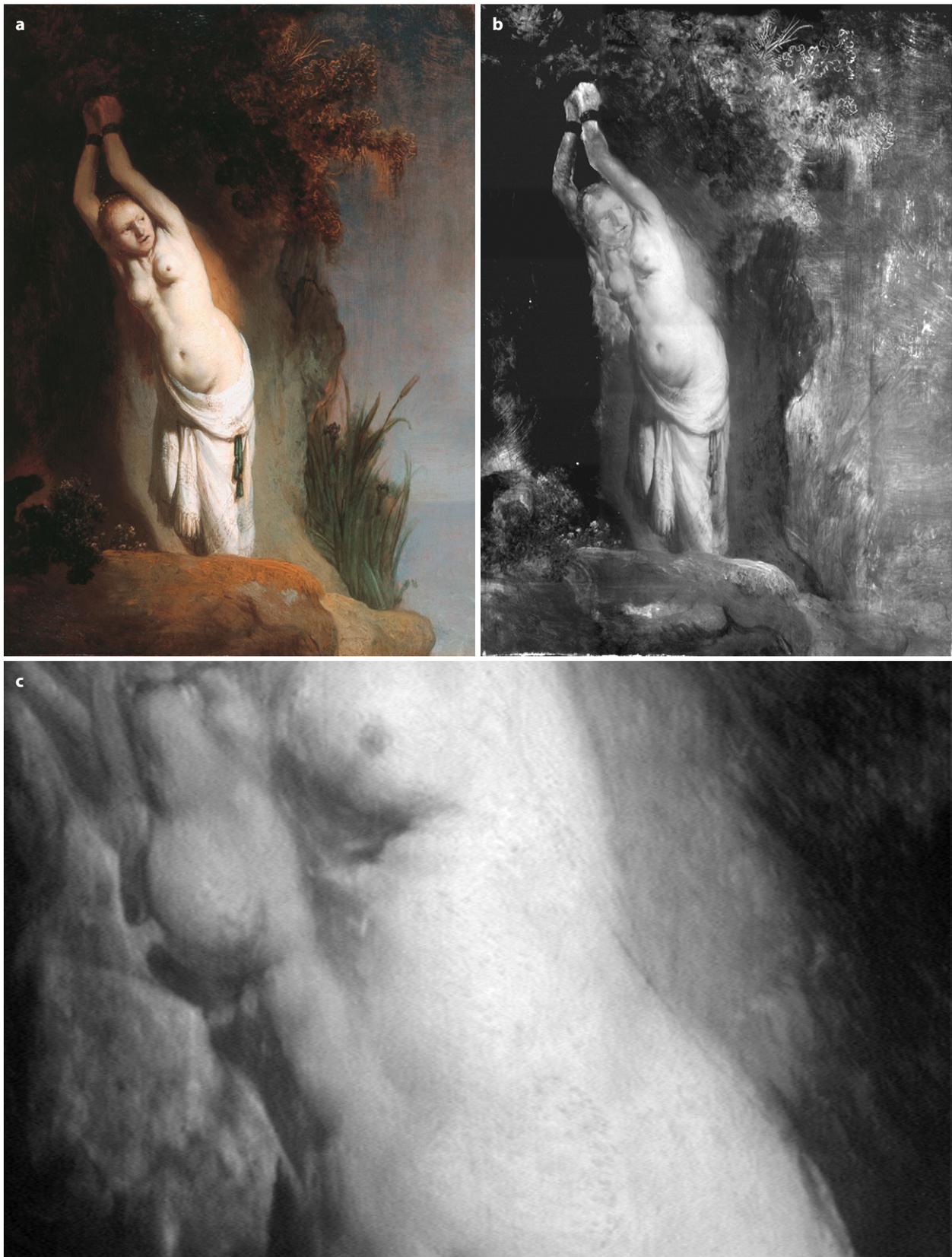


Figure 7 (a) Rembrandt, *Andromeda*, c.1630, oil on panel, 34 × 24.5 cm, Mauritshuis, The Hague, inv. no. 707; (b) infrared reflectogram of (a); (c) detail of (b). Photos (b) and (c): Jørgen Wadum

applied but advanced technique of searching for Rembrandt's underdrawing using neutron autoradiography, which was initiated some decades ago at the Metropolitan Museum of Art in New York,⁵³ has been revised more recently at the Gemäldegalerie, Staatliche Museen zu Berlin.⁵⁴ One of their more recent examinations was of Rembrandt's *Susanna and the Elders* painted in 1636.⁵⁵ The neutron autoradiography study revealed indications of delineation for the figures in the composition and in the final autoradiograph the distribution of phosphorus arising from bone black in the underdrawing was recorded. Among other compositional changes it is possible to observe the arm of the man behind Susanna reaching down towards her left arm. The same working procedure also seems to have been used in Rembrandt's much later painting from c.1659–60 depicting *Jacob Wrestling with the Angel* (Berlin, Gemäldegalerie, Staatliche Museen zu Berlin).⁵⁶ In his first sketch Rembrandt positioned the angel's hand at the level of Jacob's shoulder; by subsequently moving it up he transformed the struggle into an embrace.⁵⁷

In the sixth and final volume of the *Corpus*, however, it is interesting to note that a recent reattribution of a painting to Rembrandt, *Lighting Study with Hendrickje Stoffels in a Silk Gown as a Model* c.1659 (Frankfurt, Städelsches Kunstinstitut)⁵⁸ repeats the assertion that Rembrandt did not use black chalk or other drawing materials for his underdrawings but that he habitually sketched his composition with a brush from early in his career. In the IRR image of this portrait, the author states that 'traces of free, broad brushstrokes are visible which sometimes (but not always) correspond with the visible surface image. Such lines, which are sometimes straight and do not always correlate with the folds on the surface of the present painting, evidently belong to the first design.'⁵⁹ This idea confirms our recent research and observations on Rembrandt's work and that IRR imaging may be able to provide a wealth of new information on the initial stages of Rembrandt's painting method.

Conclusions

Future studies will show whether the use of linear compositional drawings, in a dry or fluid medium, actually occurs more often in Rembrandt's works



Figure 8 Rembrandt, *Half-length Portrait of a Woman with a Beret*, 1643, oil on panel, 75 × 60 cm, Gemäldegalerie, Staatliche Museen zu Berlin, Berlin, inv. no. I.905: infrared reflectogram detail. Photo © C. Schmidt, SMB (CC BY-NC-SA by copyright: Gemäldegalerie, Staatliche Museen zu Berlin).

than we have indicated here. As well as Lastman, Dou and Fabritius, other artists from Rembrandt's immediate ambit must have made use of an initial underdrawing. Although Rembrandt's paintings have been documented with exemplary comprehensiveness by the RRP and other researchers, new or improved methods of research – including extensive IRR documentation – will lead to the discovery of previously unrecorded information on his painterly procedures. This will help us not only to better understand Rembrandt's technique but also those of his contemporaries, leading to a greater appreciation of his genius. A comparative analysis of the early copies made by his students and assistants within the Rembrandt workshop after prototypes by the master (the so-called 'satellite pictures') would be a logical continuation of this IRR research. There is no doubt that the RKD Rembrandt Database will play a significant role in elucidating wider evidence of material uses and artists' choices as well as a greater understanding of the working methods employed.

It would be unrealistic, however, to expect that we will ever be able to discover the complete truth with regard to the painting techniques of the seventeenth century, but if we are as persistent in our search as Andromeda's eternal lookout for the absent Perseus in Rembrandt's small Mauritshuis panel, then we may reach a much closer understanding of the details of the artistic creativity of Rembrandt and his contemporaries.

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Notes and references

1. Van de Wetering, E. (2014), *A Corpus of Rembrandt Paintings VI. Rembrandt's Paintings Revisited: A Complete Survey*, Dordrecht, Springer.
2. Bevers, H., Hendrix, L., Robinson, W.W. and Schatborn, P. (2009), *Drawings by Rembrandt and his Pupils: Telling the Difference*, exh. cat., Getty Center, 8 December 2009–28 February 2010.
3. Available at: http://www.getty.edu/art/exhibitions/rembrandt_drawings/ (accessed October 2021).
4. Van Mander, K. (1604), *Het schilder-boeck* (1969 facsimile), Utrecht, Davaco Publishers, Chapter 12: *Van wel schilderen, oft Coloreren*. Available at: http://www.dbnl.org/tekst/mand001schi01_01/mand001schi01_01_0014.php#499T (accessed October 2021).
5. Sir Theodore Turquet de Mayerne (1620–1646), *Pictoria, sculptoria et quae subalternarum artium* (the 'Mayerne manuscript', Sloane MS 2052).
6. Van Hoogstraten, S. (1678), *Inleyding tot de hooge schoole der schilderconst: anders de zichtbaere werelt*.
7. Van Houbraken, A. (1718–21), *De groote schouburgh der Nederlantsche konstschilders en schilderessen*, 3 parts.
8. Miedema, H. (1973), *Karel van Mander: Den grondt der edel vry schilder-const*. Utrecht, Haentjens Dekker & Gumbert: 98.
9. Van Asperen de Boer, J.R.J. (1968), 'Infrared reflectography: a method for the examination of paintings', *Applied Optics* 7(9): 1711–14.
10. Van Asperen de Boer, J.R.J. (1970), *Infrared Reflectography: A Contribution to the Examination of Earlier European Paintings*, PhD thesis, Amsterdam, Central Research Laboratory for Objects of Art and Science.
11. Bruyn, J., Haak, B., Levie, S.H., Van Thiel, P.J.J. and Van de Wetering, E. (1982), *A Corpus of Rembrandt Paintings I*, The Hague/Boston/London, Martinus Nijhoff Publishers: XII.
12. Bruyn *et al.* 1982 (cited in note 11); Bruyn, J., Haak, B., Levie, S.H., Van Thiel, P.J.J. and Van de Wetering, E. (1986), *A Corpus of Rembrandt Paintings II*, Dordrecht/Boston/Lancaster, Martinus Nijhoff Publishers; Bruyn, J., Haak, B., Levie, S.H., Van Thiel, P.J.J. and Van de Wetering, E. (1989), *A Corpus of Rembrandt Paintings III*, Dordrecht/Boston/London, Martinus Nijhoff Publishers; Van de Wetering 2014 (cited in note 1).
13. Van de Wetering 2014 (cited in note 1) 728.
14. Bruyn *et al.* 1982 (cited in note 11) 20.
15. *Ibid.*, 20, P. Lastman, *Triumph of Mordecai*, Rembrandt House, Amsterdam. IRR made by the Central Laboratory, Amsterdam.
16. On Johannes (Hans) Hell (1897–1974) see Runeberg, U. (2005), 'Immigrant picture restorers of the German-speaking world in England from the 1930s to the post-war era', in *Arts in Exile in Britain 1933–1945: Politics and Cultural Identity, Yearbook of the Research Centre for German and Austrian Exile Studies* 6, 2004, ed. S. Behr and M. Malet, Amsterdam/New York, Rodopi: 339–71.
17. Bruyn *et al.* 1982 (cited in note 11) 21.
18. The CCD camera provided viewing in the near IR region of the spectrum, around 800–1000 nm.
19. Wadum, J. (2000), 'Rembrandt under the skin: the Mauritshuis *Portrait of Rembrandt with Gorget* in retrospect', *Oud Holland* CXIV: 164–87.
20. Grimm, C. (1991), *Rembrandt selbst: Eine Neubewertung seiner Porträtkunst*. Stuttgart/Zürich, Belser; Chong, A. (ed.) (2000), *Rembrandt Creates Rembrandt: Art and Ambition in Leiden, 1629–1631*, exh. cat., Isabella Stewart Gardner Museum, Boston, 21 September 2000–7 January 2001: 95–7 and note 4. Chong not only agrees that the Mauritshuis painting is not by Rembrandt but also asserts that for him Grimm's argument was the point of no return.
21. See Miedema 1973 (cited in note 8).
22. Van de Wetering, E. (1997), *Rembrandt: The Painter at Work*, Amsterdam, Amsterdam University Press: 47–73.
23. See also Bolten, J. (1985), *Method & Practice: Dutch and Flemish Drawing Books 1600–1750*, Landau, Pfalz, PVA. Van Mander 1604 (cited in note 4), describes this at length in Chapter 2 of his *Grondt*.
24. Van de Wetering 1997 (cited in note 22).
25. See Miedema 1973 (cited in note 8) cap. 12:7, 254.
26. No other known apprentices such as Govaert Flink (1615–1660), Ferdinand Bol (1616–1680) and G. van Eeckhout (1621–1674) were examined as they are not mentioned in relation to Rembrandt before 1635, the limit of our first research.
27. Sluijter-Seijffert, N. and Wolters, M. (2009), 'Samenwerking tussen Alexander Keirincx en Cornelis van Poelenburch belicht', *Oud Holland* 122(1): 14–42; Wadum, J., Scharff, M. and Monrad, K.

- (2009), 'The multiple views of Italy by Danish Golden Age artists: reality or manipulation?' in *The Quest for the Original: Underdrawing and Technology in Painting (Symposium XVI)*, ed. H. Verougstraete and C. Janssens de Bisthoven, Leuven, Peeters: 143–51.
28. The Rembrandt Database is an inter-institutional research resource for information and documentation on paintings by Rembrandt – or attributed to him, either now or in the past – in museums around the world. Available at: <http://rembrandtdatabase.org/> (accessed October 2021).
 29. Oil on panel, 74.6 × 101 cm, Museum Boijmans Van Beuningen, Rotterdam. See Van de Wetering 1997 (cited in note 22): Van de Wetering believes that this painting is a finished model for a print.
 30. The dead colouring consists mainly of Cologne earth with admixtures of black and/or red pigments. See Noble, P. and Wadum, J. (1998), 'Rembrandt's painting technique in the *Anatomy Lesson of Dr Nicolaes Tulp*', in *Rembrandt Under the Scalpel: 'The Anatomy Lesson of Dr Nicolaes Tulp' Dissected*, N. Middelkoop, P. Noble, J. Wadum and B. Broos, The Hague, Mauritshuis: 66–7.
 31. Proteinaceous material was found in *The Concord of the State*, Museum Boijmans Van Beuningen, Rotterdam and in Rembrandt and/or studio, *Tronie of an Old Man*, Mauritshuis, The Hague, inv. no. 565 by K. Groen; protein was also detected in Workshop of Rembrandt, *Holy Family at Night*, Rijksmuseum, Amsterdam, inv. no. SK-A-4119 (A. Wallert, pers. comm., 1999). See also Van de Wetering 1997 (cited in note 22) 27.
 32. The use of gum water or egg in combination with blue pigments is known from, for example, Van de Graaf, J. (1958), *Het De Mayerne manuscript als bron voor de schildertechniek van de Barok*, Mijdrecht, Brukker: 178; and from Groen, K. (1997), 'Investigation of the binding medium used by Rembrandt', *Kunsttechnologie und Konservierung* 2: 207–27.
 33. Oil on panel, 68.6 × 53.4 cm, Rijksmuseum, Amsterdam.
 34. Rembrandt, *Young Woman in Fantasy Costume*, 1633, oil on panel, 65 × 48 cm, Rijksmuseum, Amsterdam, inv. no. SK-A-4057.
 35. Rembrandt, *Self-Portrait with a Velvet Beret and Gold Chain*, 1633–36, oil on panel, 56 × 47 cm, Gemäldegalerie, Staatliche Museen zu Berlin, Berlin, inv. no. 808. See IRR image in The Rembrandt Database, record 16697. Available at: <https://rkd.nl/explore/technical/5006354> (accessed October 2021).
 36. See Van de Wetering, E. (2011), *A Corpus of Rembrandt Paintings V. Small-Scale History Paintings*, Dordrecht, Springer: 207, for Rembrandt, *Parable of the Labourers in the Vineyard*, 1637, oil on panel, 31 × 42 cm, The State Hermitage Museum, St Petersburg, inv. no. 757.
 37. Van de Wetering 2011 (cited in note 36) 207.
 38. Miedema 1973 (cited in note 8) cap. 12:5, 253 and cap. 12:24, 261.
 39. Van de Wetering 2011 (cited in note 36): 345. Oil on panel, 55.4 × 74.5 cm, The Metropolitan Museum of Art, New York, acc. no. 14.40.651.
 40. Wadum, J. (2002), 'Dou doesn't paint, oh no, he juggles with his brush: Gerrit Dou, a Rembrandtesque "Fijnschilder"', *Art Matters – Nederlands Technical Studies in Art* 1: 62–77.
 41. Oil on canvas, 210 × 140 cm, National Museum, Warsaw, acc. no. M.Ob.563.
 42. Oil on canvas, 157.5 × 136 cm, The Leiden Collection, New York.
 43. During the monographic exhibition *Carel Fabritius 1622–1654: Young Master Painter* (Mauritshuis, The Hague, 24 September 2004–9 January 2005, Staatliches Museum, Schwerin, 28 January–30 May 2005) the exhibited works were investigated by CCD imaging. The results were presented by the current author during a symposium in Schwerin, Germany, on 28 May 2005, and later these technical aspects of Fabritius' painting technique were incorporated in an article by Duparc, F.J. (2006), 'Results of the recent art-historical and technical research on Carel Fabritius's early work', *Oud Holland* 119(2/3): 76–89.
 44. I am grateful to Gero Seelig, curator at the Staatliches Museum Schwerin, for sharing his thoughts on the artistic development of the young Fabritius in his formative years. See Seelig, G. (2006), 'The dating of Fabritius's stay in Amsterdam', *Oud Holland* 119(2/3): 93–98.
 45. Sumowski, W. (1983–95), *Gemälde der Rembrandt-Schüler*, vol. 5, Landau, Pfalz: 3096 (no. 2071).
 46. Wadum, J. (2020), 'Are the changed appearances of Carel Fabritius' paintings a consequence of mobility?', in A. Haack Christensen, A. Jager, J. Townsend (eds.), *Ground Layers in European Painting 1550–1750: CATS Proceedings*, V, 2019: 107–17, Archetype Publications Ltd.
 47. Bruyn *et al.* 1982 (cited in note 11) 22–3.
 48. Oil on panel, 34 × 24.5 cm, Mauritshuis, The Hague, inv. no. 707.
 49. Oil on panel, 75 × 60 cm, Gemäldegalerie, Staatliche Museen zu Berlin, Berlin, inv. no. I.905. I am grateful to Claudia Laurenze-Landsberg and Dr Katja Kleinert, Berlin, for drawing our attention to this discovery. It should be noted that in the past the painting has been questioned by several scholars, including the RRP (Van de Wetering 2011 [cited in note 36] 351, ill. 15; Van de Wetering 2014 [cited in note 1] 57–8, ill.12). Despite continued doubt as to the painting's attribution (Katja Kleinert and Claudia Laurenze-Landsberg, SMB, personal communication, 2016), Van de Wetering in Vol. VI of the *Corpus* (Van de Wetering 2014 [cited in note 1] 57–8, ill. 12. and 582, 584) again included it

- as a work by Rembrandt's own hand. For a discussion of this painting see Record 19532 in The Rembrandt Database: <https://rkd.nl/explore/technical/5010028> (accessed October 2021)
50. Oil on canvas, 132.4 × 102.8 cm, The Frick Collection, New York, acc. no. 1906.1.97. Van de Wetering, E. (2005), *A Corpus of Rembrandt Paintings IV. The Self-Portraits*, Dordrecht, Springer: 463.
 51. ARTnews, June 25, 2021: <https://www.artnews.com/art-news/news/lost-rembrandt-found-italy-adoration-of-the-magi-1234597041/> (accessed 29 June 2021).
 52. Van de Wetering, E. (2011), *A Corpus of Rembrandt Paintings V. Small-Scale History Paintings*, Dordrecht, Springer: 180–85.
 53. Ainsworth, M.W., Brealey, J., Haverkamp-Begemann, E., Meyers, P. with the assistance of Groen, K., Cotter, M.J., Van Zelst, L. and Sayre, E.V. (1982), *Art and Autoradiography: Insights into the Genesis of Paintings by Rembrandt, Van Dyck, and Vermeer*, New York, The Metropolitan Museum of Art.
 54. See the paper by Laurenze-Landsberg and Kleinert, in this volume.
 55. Oil on mahogany panel, 77 × 93 cm, Gemäldegalerie, Staatliche Museen zu Berlin, Berlin, inv. no. 813.
 56. Oil on canvas, 137 × 116 cm, Gemäldegalerie, Staatliche Museen zu Berlin, Berlin, inv. no. 828.
 57. Laurenze-Landsberg and Kleinert 2019 (cited in note 49).
 58. Oil on panel, 72.5 × 51.5 cm, Städelsches Kunstinstitut, Frankfurt; Van de Wetering 2014 (cited in note 1): 659–63.
 59. *Ibid.*, 662–3, fig. 2.

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Rembrandt and Bol in the Royal Collection: a close examination of Rembrandt's *Portrait of Agatha Bas* and Ferdinand Bol's *Rembrandt and his Wife Saskia*

Rosanna de Sancha

ABSTRACT This paper describes the technical comparison of two paintings in the Royal Collection: Rembrandt's *Portrait of Agatha Bas* and Ferdinand Bol's *Rembrandt and his Wife Saskia*, both of which were produced by Rembrandt's studio when he was at the height of his powers as a portrait painter. The history of royal collecting and the changing language of connoisseurship are also discussed.

Introduction

In 1633 Charles I acquired one of the first paintings by Rembrandt to arrive in England: *An Old Woman: The Artist's Mother (?)*.¹ Rembrandt was 27 years old when the painting entered the British Royal Collection. By the middle of the nineteenth century, 15 paintings in the Royal Collection had been purchased and recorded in inventories as being by Rembrandt. Since then, the number of paintings by the artist has fluctuated, partly as a result of dispersal and purchase, but mainly as the consequence of deeper examination and subsequent reattribution to other Dutch seventeenth-century painters, including William de Poorter, Rombout van Troyen and Ferdinand Bol. The publication in 2016 of the revised edition of the catalogue of Dutch paintings in the Royal Collection by Professor Sir Christopher White included close examination of the paintings by Rembrandt and his circle.² The six paintings currently attributed to Rembrandt will no doubt continue to be studied, alongside those described as 'in the style of

Rembrandt', and those produced by pupils, assistants or followers of Rembrandt, described as 'satellites' by Ernst van de Wetering in the last volume of the *Corpus of Rembrandt Paintings*.³

The portrait of Agatha Bas (Fig. 1) and that of her husband Nicolaes van Bambeeck (Fig. 3) were listed as lots 76 and 77 in Christie's auction catalogue dated 29 June 1814: 'two matchless portraits of a Burgomaster and his lady, by Rembrandt'. The latter, the entry continued, was 'considered one of the finest productions of his pencil ... a wonderful effort of the art ... the delineation from nature is agreeable and true ... the rich and glowing tints are the ne plus ultra of the art'. The picture was described as, 'this extraordinary performance'.⁴ The *Portrait of Agatha Bas* (Royal Collection Trust, RCIN 405352) was executed when the sitter had been married to the successful wool merchant Nicolaes van Bambeeck for three years and while she was pregnant with their second child. The variety in technique throughout the apparently unified painting is interesting: Rembrandt made particular local use of colour and



Figure 1 Rembrandt, *Portrait of Agatha Bass ('Lady with a Fan')*, signed and dated 1641, oil on canvas, 105.4 × 83.9 cm. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

carried out only careful and specific modifications to the composition.

Two years later, George IV purchased a further painting then ascribed to Rembrandt in the Hope sale of 27 June 1816. Described in the sale catalogue as *The Burgomaster Pancras and his Wife*,⁵ this painting has been variously catalogued as 'copy after Rembrandt' and 'anonymous Rembrandt School'. The sitters have now been identified as Rembrandt and his wife Saskia, who died in 1642, and the present attribution is to Ferdinand Bol (Fig. 2).⁶ A close comparison of these two paintings reveals information about Rembrandt's dynamic style at a high point in his own development, and how his painting techniques were translated in the hands of another artist, Ferdinand Bol. Practical examples from the paintings have been used to illustrate the term 'in the style of' a painter.

Both paintings have a Rembrandt signature: the *Portrait of Agatha Bas* is clearly signed 1641 and the painting is inscribed with her age: 'AE29'. The date on the painting attributed to Bol is less clear and could be 1641, 42 or 44. The signature in the



Figure 2 Attributed to Ferdinand Bol, *Rembrandt and his Wife, Saskia*, 1635–40, oil on canvas, 154.0 × 199.0 cm. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.



Figure 3 Rembrandt, *Portrait of Nicolaes van Bambeeck*, 1641, signed and dated 1641, oil on canvas, 105.5 × 84.0 cm. Photo: J. Geleyns © Royal Museum of Fine Arts of Belgium, Brussels.



Figure 4 Rembrandt, *Young Woman with Earrings*, 1657, oil on panel, 39.5 × 32.5 cm, The State Hermitage Museum, St Petersburg. Photograph © The State Hermitage Museum. Photo by Leonard Kheifets.

style of Rembrandt is located at the right-hand side of the painting above the table. There is also a false signature on the reverse of the mirror in the centre of the composition, which had long been considered authentic. They were loaned by Queen Victoria, as autograph Rembrandts, to the large Rembrandt exhibition held in Amsterdam in 1898, and the double portrait was given a prominent central position as a famous painting by the artist even though at the time of the exhibition its attribution was in question. The art critic Jan Veth described it as: ‘a disappointment ... one would have expected more ... notwithstanding the richness of the jewellery and gown it is not at all effective.’⁷

A comparison of the two paintings clarifies what ‘in the style of’ means in the context of Rembrandt’s workshop practice. One painting is by the master, the other probably by his assistant. Both paintings exploit light and the reflection of light, and both were produced by Rembrandt’s studio when he was at the height of his powers as a portrait painter, with mastery of the possibilities of the *trompe l’oeil* portrait, combining artifice with an intense and searching eye. Bol was either about to leave Rembrandt’s studio around

1641 or had already set up what would become his own very flourishing and profitable workshop. He had worked as Rembrandt’s assistant since 1635 and therefore had an intimate knowledge of the master’s technique and was evidently influenced by it, as evidenced by his drawings and etchings as well as in his paintings. Work produced in Rembrandt’s studio by Bol would not have carried his signature.⁸ A record of a later copy, possibly by Bol, of the *Portrait of Agatha Bas*⁹ illustrates the ongoing adoption of Rembrandt’s technique. Further questions regarding these studio relationships are raised by a small portrait on panel, *Young Woman with Earrings* (Fig. 4), catalogued as by Rembrandt (St Petersburg, State Hermitage Museum), which, although dated 1657, is a similar representation of the woman depicted in Bol’s Royal Collection double portrait.

Technical comparison

A comparative examination of the two Royal Collection paintings was facilitated by the excellent



Figure 5 Rembrandt, *Portrait of Agatha Bas ('Lady with a Fan')*: detail of the mouth showing the undermodelling layer. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.



Figure 6 Attributed to Ferdinand Bol, *Rembrandt and his Wife, Saskia*: detail of the mouth showing the degree of finish. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

state of preservation of both. Each has an early lining; there is a record in the stock books of the dealer John Smith of a lining of the *Portrait of Agatha Bas* in 1816.¹⁰ In both cases, the impasto and the thinnest areas of paint have remained virtually intact. Buttery noted in his account books recording a minor treatment in 1951 of *Agatha Bas*, that the painting was 'in an almost perfect state.'¹¹ The painting underwent a full conservation treatment in 2002.¹² The Bol has a lining dating from before the twentieth century, but when the full treatment was carried out in 2014–15 it had not been treated for a considerable time; it was described in the Redgrave inventory of 1868 as 'sound but toned brown.'¹³

An analysis of the stylistic interchange between painters requires an investigation of the materials and stages of painting, as much as a comparison of the final surface appearances. The exceptional state of preservation of the *Portrait of Agatha Bas* required that most of the information was gathered using non-destructive analytical methods therefore it was examined using X-radiography, infrared reflectography (IRR), X-ray fluorescence analysis (XRF) and close examination under the microscope. One cross-section had been taken as part of the investigation by the Rembrandt Research Project into ground layers in Rembrandt's work.¹⁴ The dimensions of the painting are 105.4 × 83.9 cm and the canvas has 12 threads per cm in the warp and weft directions. The original tacking edges had been removed and trimmed closely to the canvas edge at some stage during a past lining treatment. Cusping is still visible along all edges: it is particularly apparent

along the entire bottom edge, but more visible to the left of the fan where the paint layers are thicker. The painting has a thin double ground: the first layer is a red ground layer containing some umber, while the second is composed predominantly of lead white with a little bone black and umber. The red ground layer plays no part in the final composition, whereas the light grey second ground would have been applied with the portrait in mind. In the pendant *Portrait of Nicolaes van Bambeeck* (Brussels, Royal Museums of Fine Arts of Belgium) there is a similar application of ground layers; the combination of a red ground followed by a second layer, greyish and pearlescent in appearance, providing little coverage, is not perceptible at the paint surface.¹⁵ In the *Portrait of Agatha Bas*, both ground layers are visible around the edges, but no red ground layer can be observed in the painting. The grey layer, however, does have an influence in many areas of the composition, for example in the modelling in the face where the paint, although made of opaque pigments, is very thin, and similarly in the painting of the hands. In the face the painting is at its most economical and careful, with the light grey ground providing a very luminous effect. This somewhat reflective grey ground also shows through in the hair, where modelling layers are visible and incorporate more distinct painted lines within the thin loose and diluted areas of paint.

As whites and light greys form the significant and most striking part of the painting, in certain areas it is difficult to differentiate between ground and modelling. There is a light grey layer, for example, that

could be part of a modelling 'grisaille' stage, above the sitter's fan, at the boundary between her black dress and stomacher. In contrast, Bol, in his double portrait of *Rembrandt and his Wife Saskia*, has not made use of the potential of the ground layer in the composition; there are very limited glimpses of what appears to be a single buff-grey ground layer. It is particularly visible in the reserve around the fingers but does not play a significant role in the composition of the painting or its overall tonality. Ferdinand Bol, who would have been very closely influenced by Rembrandt's working practice when in the studio, did not allow all his stages in the working process to have an impact on the finished composition. This is evident in the face and particularly on the sides of the heads that are in shadow, where the differences in the construction of the image are revealing. In the painting of *Agatha Bas*, the main focus of attention is the face, which is captured with an almost shocking economy of paint using the 'grisaille' stage, the warm grey modelling layer that underpins the woman's intent gaze (Fig. 5). The extensive use made of the lower layers gives greater force to Rembrandt's penetration of the character of the sitter. Bol, by contrast, does not economise in his application of paint in this way at these stages of the painting process. As can be seen in the detail of the face, in the pursuit of an even and elegant surface finish he chose to blend the paint more smoothly than Rembrandt (Fig. 6).

The methods used to set the sitter(s) in the pictorial space also reveal differences in approach and outcome between the two painters. In the *Portrait of Agatha Bas*, there is a more generous reserve left for the figure, which can be seen more clearly in the infrared reflectogram. As the painting of the figure in the fictive frame progressed, alterations in local details and in the position of the figure resulted in a general overall reduction in size. At the boundaries between the figure and the surrounding space, the reserve is visible around the shoulder, executed in transparent browns. In the area around her index finger, in contrast, there is a more highly coloured modelling layer of a distinct transparent maroon colour, with painted outlines worked into it. The 'grisaille' modelling, visible in the face and neck, can also be detected in other places, for example in her hand holding the fictive frame and her stomacher. A monochrome modelling layer has also been found



Figure 7 Rembrandt, *Portrait of Agatha Bas ('Lady with a Fan')*: detail of the wrist showing the coloured shadows and highlights. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

in the *Portrait of Nicolaes van Bambeeck*.¹⁶ Notably, Rembrandt made a real distinction in the modelling of the eyes of *Agatha Bas*: the eye located in shadow relies heavily on the 'grisaille' or 'dead-colouring' stage, but in the modelling of the other eye his use of highlights, red tones and scratching back into the paint – adding and cutting back – is sculptural in approach. This is very different to the smoother more uniform structure found in the painting by Bol in which the undermodelling layer is in a less contrasting and much closer colour to the upper paint layers. The more homogenous range of colours are intended to blend with the rest of the painting of the eye.

The specific use of colour in both the upper and lower layers of the painting is a particular feature of the *Portrait of Agatha Bas*. In some areas of the background, warm maroon brushwork in the lower modelling layer functions as an early indication of a curtain. A degree of colour is used in areas where alterations or additions were made in the course of painting. This use of a flat underlayer takes different forms throughout the painting. When making local changes or alterations, Rembrandt sometimes returned to an earlier ground layer stage, applying a local warm unmodulated grey underlayer to underpin the structure of the layers laid on top. This is most visible in some changes made to the lace of *Agatha Bas's* costume.

Rembrandt is very subtle and specific in the modulation of the appearance of the pearls in relation



Figure 8 Rembrandt, *Portrait of Agatha Bas ('Lady with a Fan')*: detail of the forehead showing scratching into the paint. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.



Figure 9 Attributed to Ferdinand Bol *Rembrandt and his Wife, Saskia*: detail of the forehead showing scratching into the paint layers. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

to the overall lighting effects within the painting. Those on both her right and left wrists and around her neck are each painted differently, according to whether they are in light or shade, and function as an effective way of fixing the figure of the sitter in the compositional space. The pearls on the proper right wrist are depicted as highly modulated forms



Figure 10 Rembrandt, *Portrait of Agatha Bas ('Lady with a Fan')*: detail of the cuff showing the changes applied with broader brushstrokes. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

lying over a lower maroon undermodelling layer; they have coloured shadows, with thick apricot-coloured highlights created from a mixture of yellow earth and lead white (Fig. 7). The pearls on her left hand, holding the fictive frame, however, are equally carefully modulated, but without the additional coloured strokes of light. The pearls under her chin are more muted, with less modelling, since they are represented in shadow.

Rembrandt was characteristically very economical with the paint in certain areas, in his juxtaposition of layers as well as their build up. In the application of Agatha Bas's hair to the left of the face, he exploited the optical appearance of an earth colour placed against white and black to allow the viewer to construct a sense of the space from these relatively basic planes. Another economical and bravura technique is Rembrandt's use of scoring and scratching through lower and highlight layers, moving wet paint apart and giving it defined scored edges (Fig. 8). This process of scoring through lower modelling layers and highlights of paint on top creates a third dimension to the structure, since cutting through the paint reveals a complex and subtle layering of which the viewer would otherwise be unaware. In contrast, Bol, aware of this technique and of its function, used it in the lower layers, which were then partially concealed with paint strokes on top (Fig. 9). Yet here it remains just a token Rembrandtesque element: a decorative but flat passage of paint in the face. Bol scored into the transparent layer applied in the forehead as well as the flat green space enclosed by the raised arm. However, these flourishes are essentially decorative rather than structural.

In fixing his sitter in space and enlarging her cuffs as part of that process, Rembrandt found he had to make changes to the lace in an exquisite area of the completed painting. The lace is created by locally painting voids, tinted according to the colour of the material below; warm strokes pass over the white paint and grey is worked over the black, building up the subtle shading that allows the lace pattern to show through. But in order to make the more substantial changes to the form of the figure and the fabrics, Rembrandt adopted a wholly different technique using richer fluid paint and a broader brush, resulting in a seemingly abstract blocking in of the space (Fig. 10). By making these corrections in a different technique and style, Rembrandt was beginning to develop the looser style of painting that later gave way to his celebrated 'rough' manner of the 1650s and beyond. Bol also made perceptible changes to the positions of the figure and the outline of the forms by using an equally loose style. Thick medium-rich brushstrokes modifying the design are used by both Rembrandt and Bol, and can be seen around the outlines of the figures particularly in the loose blocking-in of the background.

Another similarity in intention and technique when comparing Rembrandt and Bol can be seen in their imitation of textured surfaces. The fan in *Agatha Bas* shows exceptional skill: it appears to extend out of the painting and because of its texture, seems to catch the light in reality. This passage produces an effect that many have justifiably admired for its vibrant and intense display of painterly skill (Fig. 11). The painting by Bol uses similar effects for Saskia's cloak: similar translucent glazes are visible under dry, quite short brushstrokes of impasto, with further drier hatched highlights worked across and bridging the texture of the impasto (Fig. 12). Bol understood Rembrandt's technique for painting fabric and creating texture and here put it into practice by using colour in the shadows, in this case with an azurite and smalt combination. The elegant surface-rich quality is a striking feature of Bol's painting technique, and his connection to Rembrandt is most evident in his love of rich colour combinations. He used the thickness of the paint to describe light and texture most effectively, but did not penetrate so deeply the portrayal of character by complex undermodelling to the extent that Rembrandt did so effortlessly.



Figure 11 Rembrandt, *Portrait of Agatha Bas ('Lady with a Fan')*: detail of the fan. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.



Figure 12 Attributed to Ferdinand Bol, *Rembrandt and his Wife, Saskia*: detail of Saskia's cloak. Photo: Royal Collection Trust/© 2021 Her Majesty Queen Elizabeth II.

Conclusions

In a comparison of the two paintings it is possible to discern how a dominant and dynamic style influenced and was adapted in another painter's technique. The benefit of making this comparison is the greater clarity and focus that can be given to both. The painting by Bol shows an intimate knowledge of Rembrandt's technique and style, while also pointing towards the smoother and more fluid use and application of paint that he went on to develop by the 1650s. By comparing Bol's work we can see painterly references to specific techniques used by Rembrandt, in the pigment and colour mixtures, the build-up of layers, and the scored scratching-in of paint with an implement that is reminiscent of the work of an etcher.

The adoption by another artist of a style of a dynamic and explorative painter such as Rembrandt is perhaps always going to occur at a point of divergence for both. In the *Portrait of Agatha Bas* a changing technique can be seen, particularly in his corrections. Bol, however, made use of elements of an unchanging and therefore less dynamic style, reminding us of Jan Veth's understatement that this was 'not at all effective'. The principal quality in the *Portrait of Agatha Bas*, which is not reflected in the picture by Bol, is the careful and sparing technique used in all stages, important parts of which are visible in the descriptive undermodelling layer. For Rembrandt, the depth of portrayal of the character of his sitter is revealed from the earliest paint layers he applied. Bol, in depicting a relation *between* the characters, describes their interactive gestures and makes only small changes in the juxtaposition of the hands, for example, in developing his composition. The Rembrandtesque technique of scoring the paint is used as a decorative rather than structural detail, while the smooth high finish of the paint layers in the faces, and rich local colour throughout, points to the very different future direction that he would take from that of his master.

Notes and references

1. White, C. (1982), *The Dutch Pictures in the Collection of Her Majesty The Queen*, Cambridge, Cambridge University Press: 101.
2. White, C. (2016), *The Dutch Pictures in the Collection of Her Majesty The Queen*, 2nd edn, London, Royal Collection Enterprises.
3. Van de Wetering, E. 2014. *A Corpus of Rembrandt Paintings VI. Rembrandt's Paintings Revisited: A Complete Survey*, Dordrecht, Springer: 56.
4. Christies London (1814), Italian, Flemish and Dutch Pictures, 29 June 1814, lot 77.
5. Christies London (1816), Italian, French, Flemish and Dutch Pictures, 27–29 June, 1816.
6. White 2016 (cited in note 2) 27.
7. Veth, J. (1898), 'Uit een geannoteerden catalogus van de Rembrandt-tentoonstelling' (from an annotated catalogue of the Rembrandt exhibition), *De Kroniek* 201(4): 335.
8. Van der Wetering, E. (2006), 'Principaalen and satellites: pupils' production in Rembrandt's workshop', in *Rembrandt: The Master and his Workshop*, ed. L. Ronberg, L. B. Pederson and E de la Fuente, exh. cat., Copenhagen, Statens Museum for Kunst: 109.
9. Sotheby's Amsterdam, Old Master Paintings, 15 November 2005, lot 74.
10. B. Fredericksen in The Royal Collection curatorial records at York House, London, noted a reference to lining a painting presumed to be Agatha Bas, when examining Smith's stock books (personal communication).
11. Buttery, H., Daybook December 1951 No 9, 'almost perfect state. A few pinhole spots in blacks and loss of glaze her left cheek bone small damage to left of hand'. Held at the Hamilton Kerr Institute, Cambridge.
12. I am grateful to Rupert Featherstone (director, Hamilton Kerr Institute) for discussing the treatment of the painting.
13. Redgrave, R. (1868), *The Inventory of the Pictures in the Collection of Queen Victoria*.
14. Groen, K. (2005), 'Grounds in Rembrandt's workshop and in paintings by his contemporaries', in E. Van de Wetering, *A Corpus of Rembrandt Paintings IV: The Self-Portraits*, Dordrecht, Springer: 318–34.
15. Dubois, H., Rosier, F. and De Belieet, L. (2013), 'Le portrait de Nicolaes van Bambeeck par Rembrandt. Technique d'une oeuvre magistrale', *Bulletin de l'Institut Royal du Patrimoine Artistique* 33: 191–204, esp. 196.
16. Dubois *et al.* 2013 (cited in note 15) 199.

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Rembrandt's *Frederik Rihel on Horseback*: a restoration in context

Larry Keith

ABSTRACT The recent restoration of Rembrandt's *Frederick Rihel on Horseback* followed on from the discovery of the existence of a wholly different initial composition below the present work, a situation seemingly unique within Rembrandt's commissioned paintings. The conservation treatment allowed for a more comprehensive technical study of the portrait, including scanning XRF imaging. This study has done much to explain both the painting's somewhat unfortunate conservation history, inform the approach taken in the most recent campaign of retouching, and change our deeper understanding of the work and its place within Rembrandt's career.

Introduction

The decision to undertake a major restoration such as that of the National Gallery's *Frederick Rihel on Horseback* (Figs 1 and 2) often stems from a wish to secure its preservation or enhance its appearance. In such a model the treatment then becomes a focus of coordinated research activity across the Gallery, stimulating new ways of thinking about the painting from any number of perspectives. However, in the case of *Frederik Rihel*, the decision to embark on the treatment was made following a significant amount of earlier technical and art-historical investigation by present and former colleagues. The first modern investigation of the painting's materials and techniques was undertaken for the Gallery's *Art in the Making: Rembrandt* exhibition and associated catalogue, which was published in 1988. This research was reflected in Christopher Brown's *National Gallery Dutch School* catalogue of 1991, while the *Art in the Making* catalogue was subsequently revised and republished in 2006.¹ These studies have provided the basis and context for all the investigation and treatment which has followed, establishing key facts such as Rembrandt's frequent use of his distinctive 'quartz'



Figure 1 Rembrandt, *Portrait of Frederick Rihel on Horseback* (NG6300), c.1663, oil on canvas, 294.5 × 241 cm, National Gallery, London: before conservation treatment. Photo © The National Gallery, London.



Figure 2 Rembrandt, *Portrait of Frederick Rihel on Horseback*: after conservation treatment. Photo © The National Gallery, London.



Figure 4 Rembrandt, *Portrait of Frederick Rihel on Horseback*: X-radiograph, digital assembly. Photo © The National Gallery, London.



Figure 3 Rembrandt, *Portrait of Frederick Rihel on Horseback*: infrared photograph made in 1960. ©The National Gallery, London.

ground in later paintings and the extensive use of lake and smalt pigments – with all that has meant for our ability to read the painting today. Infrared

photography confirmed the bold sketching in of key compositional elements with broad strokes of black or nearly black paint (Fig. 3). Important changes to the composition were also identified, such as a revision to the sitter's hat, changes to the horse's head and positioning of its legs. However, at the time of the initial study it was not practicable to assemble an X-radiograph of the entire painting – there were just a few individual plates from 1960 of what seemed to be the more interesting or characteristic passages of paint handling. This remained the case until Marjorie Wieseman studied the painting further in preparation for the exhibition *Rembrandt: The Late Works* to be held 15 October 2014–18 January 2015, the results of which were published in 2010.² The digital assembly of a complete X-radiographic image of the painting yielded the surprising discovery of the presence of another composition beneath the present one, placed at right angles to the image now visible (Fig. 4).

The initial, earlier, composition shows a figure standing off-centre within a large and ambitious landscape. The X-radiograph suggests that although the painting was reasonably complete in parts, it was also far from being finished. The head, for example, appears to have been blocked-in but not fully



Figure 5 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail of the X-radiograph showing the head of the figure underneath rotated 90 degrees anticlockwise with respect to the normal orientation of the painting. Photo ©The National Gallery, London.

realised, tantalisingly leaving open the question as to whether the rather broad face was also intended to depict Rihel (Figs 5 and 6).³ In any event, the first composition was abandoned and the canvas rotated and reused for the present image. Although some of that first image may have been scraped back in the course of the reworking, additional scientific analysis undertaken by Ashok Roy in 2009 confirmed that the second painting was begun directly over the first image with no intermediate cancelling or repriming layer – a choice with important implications for the subsequent restoration history of the work (Fig. 7).⁴

The identification of the sitter in the final image as Frederick Rihel was first made in 1910 by Abraham Bredius and rests largely on the description of an equestrian portrait of him, by Rembrandt, within an inventory of Rihel's possessions made after his death in 1681. In addition, as Christopher Brown has pointed out, many items of clothing and accoutrements listed in that inventory are strikingly similar to those depicted.⁵

Frederick Rihel came as a young man to Amsterdam from Strasbourg in around 1642, and enjoyed a long and prosperous career as a merchant there until his death. It is generally agreed that the revised composition commemorates Rihel's participation in a guard of honour which accompanied a



Figure 6 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail showing Frederick Rihel's head. Photo © The National Gallery, London.

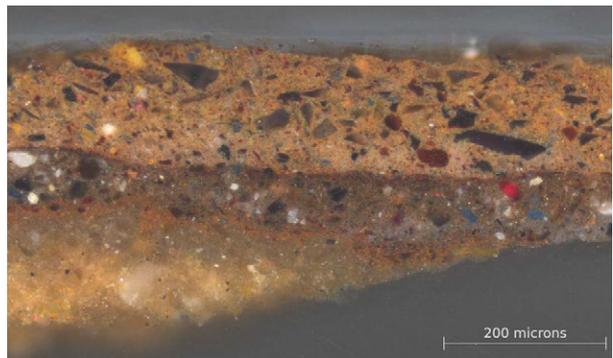


Figure 7 Rembrandt, *Portrait of Frederick Rihel on Horseback*: paint cross-section from the foreground, lower left corner. Photo © The National Gallery, London.

visit to Amsterdam by Prince William of Orange in 1660. The painting is traditionally assumed to date from 1663, not long after Rihel became a citizen of the city in 1662, another event which may have provided impetus for the creation of a work that celebrates essentially the sitter's social prominence.⁶ The painting appears to depict the gathering of the procession near what has been identified as the now-perished Heiligewegspoort. There is a carriage in the middle distance at the left carrying dignitaries, perhaps including the prince, accompanied by a driver and footmen. In the foreground, Rihel demonstrates his accomplished horsemanship by holding his horse in a sort of *levade* or *demi-volte*, the skill of which would have been appreciated by



Figure 8 Photograph showing the painting during the 1960 restoration treatment by Arthur Lucas, then chief restorer at the National Gallery. Photo © The National Gallery, London.

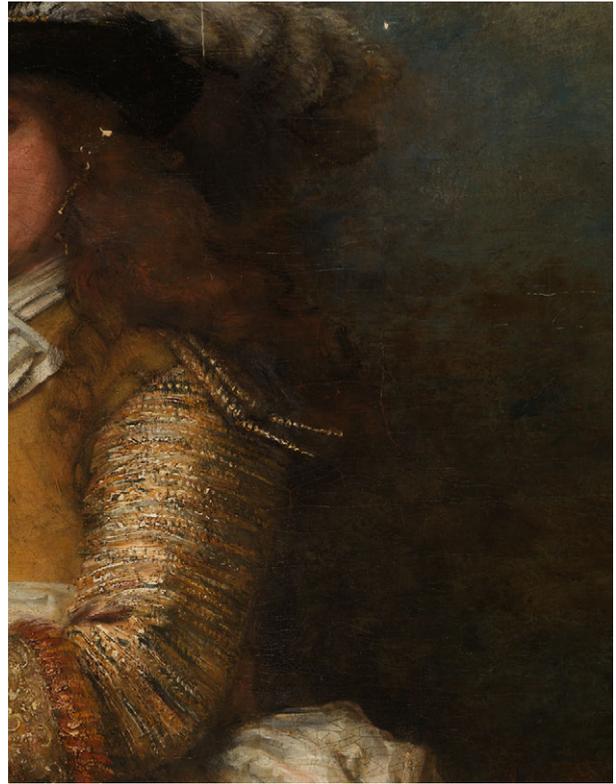


Figure 10 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail showing Rihel's sleeve after cleaning and before retouching. Photo © The National Gallery, London.



Figure 9 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail showing Rihel's sleeve with cleaning test. Photo © The National Gallery, London.

contemporary viewers.⁷ The seriousness with which such equestrian accomplishments was regarded can be seen in contemporary publications dedicated to their cultivation, such as the *Methode et invention de dresser les chevaux*, published in 1658 by William Cavendish, the first Duke of Newcastle.⁸

This body of research – in particular the more technical aspects of our own work – has implications beyond art history as it also provides a much clearer idea of how the painting had come to look the way it did and a better sense of how it might be made more legible through treatment. The accompanying discussions and exchanges between curators, scientists and conservators therefore formed an essential background and stimulus for the decision to undertake this most recent restoration.

The painting came to Britain in about 1750, when it was purchased by the 2nd Earl Cowper, remaining with his descendants until its eventual purchase by the National Gallery in 1959. In the years before its purchase it had been on public view having been loaned to the Leeds City Art Gallery from 1953, and received further exposure from a loan to the prestigious Rembrandt exhibition which was held at

the Rijksmuseum in 1956. On its acquisition by the National Gallery, the painting was cleaned rather hastily, relined with wax and restored before going on public display in 1960 (Fig. 8).⁹ Little is known of its treatment history before that acquisition, but the painting had clearly undergone many previous restorations, the effects of which became even more evident as this most recent treatment got under way. Although the 1960 relining had remained structurally sound, the varnish and retouchings applied at that time had severely discoloured. The varnish used, AW2, was a precursor of the still widely used resin MS2A, and although a very reasonable choice of material, it had something of a reputation for being relatively brittle and its surface not particularly robust.¹⁰ This concern seems to have been addressed by the unfortunate decision to add a significant amount of linseed oil to the resin, with the resulting coating becoming foggy and discoloured with a marked orange tone, in the relatively short time since it was applied. The degree of discoloration was surprising even to those of us accustomed to seeing such changes, and was first demonstrated through a few small flake losses, in the varnish only, in the subject's sleeve. Larger cleaning tests subsequently confirmed the degree of change (Figs 9 and 10). The colour shift was particularly significant in those areas that seem to be something of a Rembrandt trademark – the confident, even flashy, juxtaposition of pure white accents alongside yellow, whether in the sleeve, stirrup or elsewhere in the picture (Fig. 11). The distorting effect of the reduced saturation of the darker tones was also significant in a painting such as this, where much of the important modelling and laying out of key spatial relationships takes place within a relatively dark and restricted tonal range (Fig. 12).

The 1960 treatment seems to have involved a largely more superficial improvement of the surface, and had left unretouched a considerable degree of older damage as well as earlier discoloured retouchings still in place. As the recent cleaning progressed it also became increasingly apparent that the extent of that older damage was considerable, arising, presumably, from several earlier cycles of harsh cleaning. The darker browns and blacks used so extensively in the foreground and middle distance, applied with little or no lead white, seem to have been particularly vulnerable to the less easily controlled methods often in use before the nineteenth century.



Figure 11 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail of the stirrup after cleaning, revealing Rembrandt's use of the combination of yellow and white that was not evident beneath the discoloured varnishes. Photo © The National Gallery, London.



Figure 12 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail of the horse during cleaning showing both the degree of abrasion of the grey paint of its chest and the level of distortion given by the yellowed varnish. Photo © The National Gallery, London.

However, in this case there is probably another, more specific explanation for the apparent over-cleaning – a growing misinterpretation of features that were becoming increasingly visible from the underlying composition. It has been demonstrated that the reuse of unfinished canvases within the Rembrandt studio was not particularly unusual. Ernst van der Wetering used the term 'palimpsests' for this practice and identified some two dozen or



Figure 13 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail from the part of the horse that was applied over the abandoned figure from the first composition. After cleaning, before retouching. Photo © The National Gallery, London.

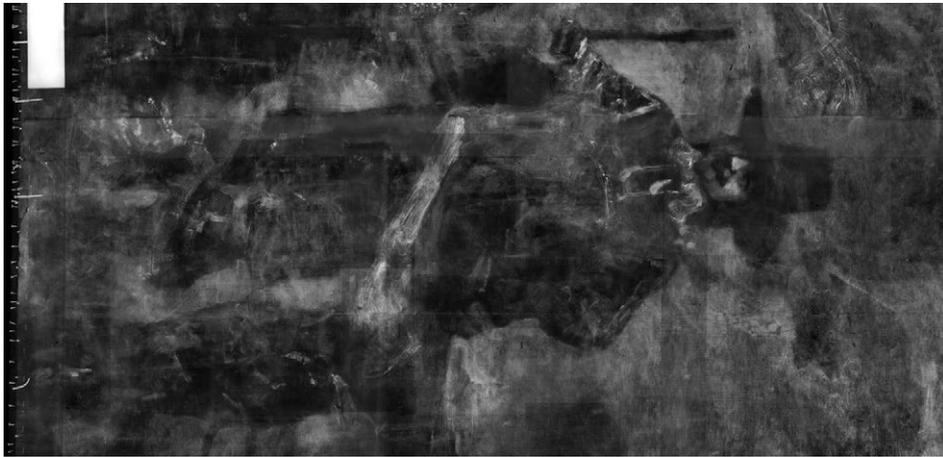


Figure 14 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail of the X-radiograph from the same area as shown in Figure 13. The underlying figure is beneath a relatively dark, transparent part of the upper painting, more vulnerable to cleaning. Photo © The National Gallery, London.

so examples, just over half of which were turned into self-portraits.¹¹ Some, like *Frederik Rihel*, were executed directly over the first composition, while others were given reprimings or ‘cancelling’ layers between images. This large painting seems to be a unique example of a commissioned portrait being executed over another composition,¹² a fact that may have some implications for the question of whether the subject of the first composition might also be Rihel, with the subsequent radical changes in the way he was depicted made perhaps at his suggestion.

Van der Wetering has described Rembrandt’s characteristic way of achieving rich and complex textures by the painter’s habit of leaving prominent textures from underlying paint showing through on

surfaces he had modified extensively. These can take the form of adjustments of forms, more comprehensive *pentimenti*, or in some cases, a ‘re-used’ passage of textured paint that first depicted something else entirely.¹³ In the case of *Frederik Rihel*, however, the prominent textural features from the first painting, poking up from below the surface of the second image, never had much functional potential in the new painting. Therefore, their contribution to the new surface must always have been somewhat disconcerting insofar as they remained visible, with little potential for becoming part of the second painting – the only possible exceptions being the areas at the upper right and lower left, which would have functioned as sky and foreground respectively

in each of the compositions. As the overlying paint became more transparent, however, the colours and textures of the underlying image must have become increasingly discernible. The use of less sophisticated cleaning methods by earlier restorers, in combination with Rembrandt's application of inherently more fragile browns and blacks over the tougher lead-containing highlights laid in beneath them, created a structure and texture that was very vulnerable to abrasion of the upper surfaces. This was the case both in the thick and prominent areas of Rembrandt's first paint applications and also where the edges of cupped paint had become raised over the time since the picture was painted. This development in the state of the painting must have been particularly confusing to the viewer given that the strongly gestural, impasto paint of the lower image that had begun to emerge in parts was not clearly distinct from the more expressive details found throughout the upper painting, as we still see, for example, in parts of the carriage and its attendant figures. Since the evidence suggests that the revealed paint is most probably by the same hand, it must have been very difficult for earlier restorers to make sense of what had developed without having any systematic knowledge of the nature of the first composition. In addition, it was unfortunate that the most worked up part of the first composition – the standing figure with its strong dashes of impasto costume details – is, for the most part, found beneath the darker, more transparent and therefore more chemically sensitive parts of the subsequent painting (Figs 13 and 14). The harshness of some of the earlier cleanings can be assessed by some aspects of the surface which became apparent over much of the painting after reducing the more recent varnishes, particularly in the more brown-black passages of the foreground. While the more raised parts of the texture were often abraded, the more recessive hollows of the paint frequently contained remains of much older, non-original coatings containing a considerable amount of oil with pine and mastic resins (these components were identified by the Scientific Department) (Fig. 15).

Interestingly, this observation is broadly consistent with a treatment probably given to the *Night Watch* (Amsterdam, Rijksmuseum) in 1697, in which it is believed that the surface was rubbed with oil; the painting was certainly cleaned as early as 1715. Early practices such as this were deplored by the

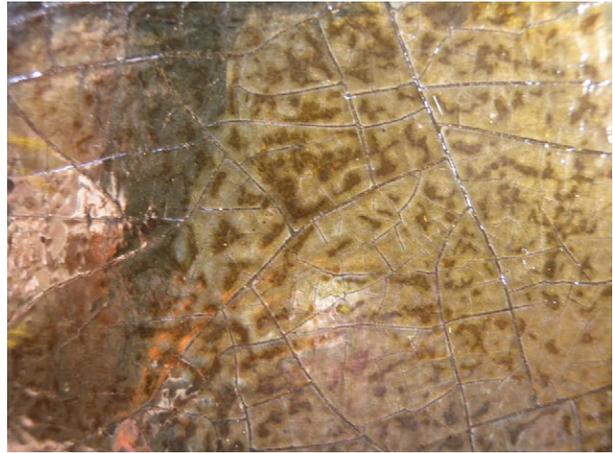


Figure 15 Rembrandt, *Portrait of Frederick Rihel on Horseback*: photomicrograph showing the remains of a very aged coating containing oil with pine and/or mastic resins trapped in hollows in the paint. Photo © The National Gallery, London.

eighteenth-century restorer Jan van Dyck when he came to clean the *Night Watch* in 1751.¹⁴ Thus on the National Gallery painting it is easy to imagine that the removal of similar dark brown, oily surface coatings, probably partly cross-linked, from relatively young brownish-black paint, perhaps using cleaning materials of less inherent control, must have been a fraught procedure. The difficulties were perhaps alleviated by the belief, although mistaken, that important original features were being uncovered. This would seem to be the case with the 'ornament' on the yellow boot, which macrophotography has shown as emerging from the mouse-coloured brown paint applied over it and reminiscent in appearance of mountains pushing up from the sea. This ornament makes little sense as a costume detail – in fact it greatly disrupts a carefully calculated chromatic effect. Without the kind of systematic knowledge of the underlying composition that X-radiography or infrared reflectography provides, from which this feature is clearly part of the decorative gold trim of the first sitter's costume, it must have seemed quite plausible as an intended part of the boot.

The recent cleaning has significantly improved the legibility of the painting, its colour relationships and spatial depiction despite the irreversible changes in the paint layers that have occurred. Many of the colour changes have been described in the *Art in the Making* catalogue and further research has been carried out by colleagues from the Scientific Department on the specifics of the behaviour of



Figure 16 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail showing the boot before restoration. A costume detail from the underlying figure has mistakenly been incorporated within the image. Photo © The National Gallery, London.

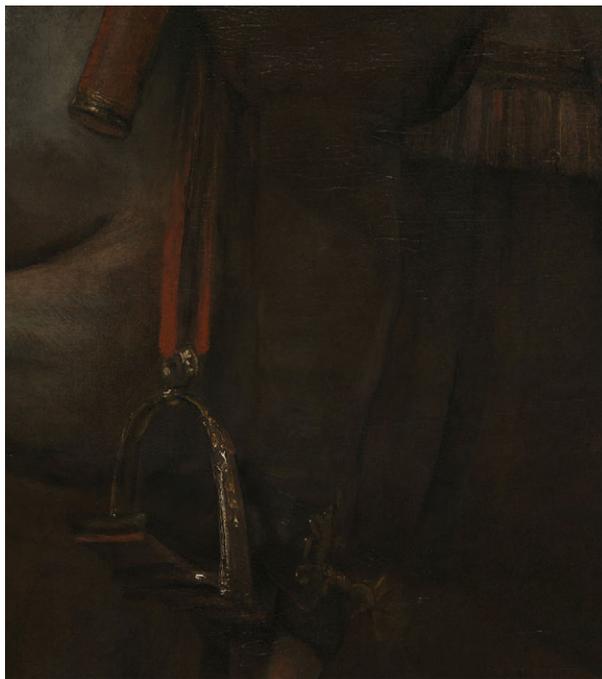


Figure 17 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail showing the boot after treatment. The mistakenly exposed costume element from the first composition has been suppressed with new retouching. Photo © The National Gallery, London.

lakes and smalt as pigments.¹⁵ Even in the context of both extensive fading and darkening, however, the cleaning has nevertheless provided a considerable aesthetic improvement. In a broader sense, any recovery of areas of cooler tone, however slight, is a significant gain for an overall appreciation of Rembrandt's more widely intended colour relationships. A simple change of seeing the sky as more blue than green, even though it is somewhat faded and stained, enhances appreciation of the greens that were intended in the foliage of the upper part of the picture, making it easier to view the painting as something quite different from a misleading accumulation of browns, whites, yellows and reds. Understanding how the colours might once have looked can also be judged, at least in the range of smaller details, by mentally substituting colour and translucency from other relatively well-preserved paintings. For example, the chalky grey-pink tone, which appears alongside the well-preserved inorganic red in the musket holster, must have been a deep, almost purple-red; something of this kind of interplay between organic and inorganic reds seems to survive well in Rembrandt's *Flayed Ox* in the Musée du Louvre in Paris.¹⁶ The challenge of retouching was therefore to restore

more of the painting's legibility while respecting inherent changes in its condition. Apart from dealing with the more obvious losses or damages, the principal concern was to reduce the visual disturbances that had resulted from the widespread abrasion and localised staining in a manner that would take full account of the increased transparency and colour change that had taken place naturally in the appearance of the painting.¹⁷

The basic approach was to proceed as appeared natural and let the painting emerge gradually – both in its colour and in the spatial relationships of the composition. Many of Rembrandt's extraordinary effects re-emerged significantly as a result of the simple reduction of the 'visual noise' around them. For example, suppressing the erroneously exposed yellow chevron in the boot made clear once again the brilliant economy by which the forward projection of the foot had been achieved. Here as it is now, the reduction of the intensity of red as the stirrup strap recedes and the intense contrast of the thick dab of pure white highlight of the stirrup effectively allow this detail to project fully, almost into the viewer's space (Figs 16 and 17). Less dramatically, but equally effectively, by reducing something of the

ghostly presence of the abandoned standing figure's staff of the first composition, the intended contours of the carriage roof were re-established, and the true position of the vertical tree and nearby architectural elements were made more clear, so that they now read more effectively as being behind it in the compositional space.

This type of retouching approach carries the risk of imposing too much order and resolution by doing more than is required to improve legibility. Part of the brilliance of the depiction of the carriage, and the figures involved, is precisely its deliberate lack of resolution, while other details below the horse's belly still defy interpretation, and it is possible that in this area some minor elements from the first composition still remain visible. This underscores the fact that, however comprehensive, the level of retouching was also intended to be conservative in intent in order to allow a measure of ambiguity within a larger goal of broader legibility in the picture. But where widespread retouching in a large painting is concerned, the borders between 'not enough', 'just right' and 'too much' are inevitably rather fluid, and the picture required many pairs of eyes during the retouching and much discussion among colleagues in order to consider and reflect matters of the painter's intent and the effects of retouching as the work progressed.¹⁸

Attempting to understand the changes the painting has undergone – or perhaps rather, to understand the limits of what we can discern about them – was therefore fundamental to our assessment of the level of finish to be aimed at in the restoration. It is also critical to a broader assessment of the deeper qualities of the painting. This kind of retouching problem requires thinking about elements both in individual detail and in relation to one another across the whole of the image. It brings to mind the concept of the Dutch term '*houding*', or very loosely translated, 'handling', that is described in seventeenth-century treatises. The associated literature can be highly theoretical and abstract,¹⁹ but the concept can be thought of as perhaps equivalent to 'orchestration' in music: the harmonious (or at least considered) co-ordination of all the effects and techniques at the painter's disposal, that is, colour relationships, tonal values, levels of finish, textural variety, compositional arrangements and so on. It was a quality that was prized particularly in Rembrandt's work,



Figure 18 Rembrandt, *Portrait of Frederick Rihel on Horseback*: detail of the sleeve showing the characteristic use of thickly textured paint for specific painterly effects. Photo © The National Gallery, London.



Figure 19 Rembrandt, *Portrait of Frederick Rihel on Horseback*: the broad loose handling stands at the other end of the spectrum of application from the impasto evident in the previous figure. Photo © The National Gallery, London.

and mentioned by commentators such as Gerard de Lairesse, Samuel van Hoogstaten and Joachim Sandraert. Whatever the uncertainty concerning the specifics of the colour changes within the Frederick Rihel portrait, the spectacular range and variety of handling and finish remain clear for all to see. The head and the sleeve are as highly worked as anything found in Rembrandt's work, with strikingly rich



Figure 20 Rembrandt, *Portrait of Frederick Rihel on Horseback* as displayed during the *Rembrandt: The Late Works* exhibition at the National Gallery in 2014–15. Photo © The National Gallery, London.

textures that result from complex build-ups of thick and thin applications of paint and its masterly working (Fig. 18). The foreground, while thickly applied, is also notably broad in handling, with a palette and manner that is, in spite of the great difference in scale, very reminiscent of the so-called *Polish Rider* in the Frick Collection in New York (Fig. 19). Much of the horse's head in *Frederik Rihel* seems to have progressed barely beyond the first 'dead colour' laying in, yet the fact that this blocking-in was given structure and articulation by the thick application of paint, confident impasto and bold scratching evident in the bridle suggests that the total effect was intended and deliberately calculated,²⁰ allowing elements of the first laying-in to be expressed in the overall final effect in a manner often found in Rembrandt's later works.

Given the painting's history of disputed authorship among critics (at least as regards parts of the composition), linking a description of painting techniques to interpretation of artistic intent is also bound to raise questions of attribution. However, there are a few aspects in the discussion of quality, if not attribution,

that it is appropriate to consider in the light of a comprehensive restoration. Whatever the painting's perceived failings, whether aspects of handling or of equine anatomy, the painting's scale and ambition is remarkable. It enlivens the trope of more conservative contemporary equestrian portraits by painters such as Thomas de Keyser and Paulus Potter, whose image of *Dirck Tulp* may have been a catalyst for the creation of Rembrandt's painting.²¹ Rembrandt more creatively turned the horse toward us, introducing complex lighting and spatial arrangements in his image and incorporating many extra narrative elements. Within this context, the variations in handling, and levels of finish and resolution, can be examined within the larger context of the creation of a total effect, and less as isolated segments to be considered in terms of their individual authorship. At the National Gallery's *Rembrandt: The Late Works* exhibition, *Frederick Rihel* was hung next to an undisputed masterpiece, the so-called *Staalmeesters* (*The Sampling Officials of the Amsterdam Draper's Guild*),²² from the Rijksmuseum, which provided as stern a test of the qualities of the Gallery's picture as

can be imagined (Fig. 20). A comparison such as this is also reinvigorated as a result of our recent treatment of *Frederik Rihel* and associated research – it allows the viewer to know more of the reasons why it has come to look as it does through its material and conservation history, our recent actions, and most of all, through Rembrandt's own, fascinating choices.

Notes and references

1. Bomford, D., Roy, A. and Brown, C. with contributions from Kirby, J. and White, R. (1988), *Art in the Making: Rembrandt*, 1st edn, London, National Gallery Company: 134–9; Maclaren, N., rev. edn. by Brown C. (1991), *National Gallery Catalogues: The Dutch School 1600–1900*, vol. 1. London, National Gallery Company: 358–62; Bomford, D., Kirby, J., Roy, A., Rüger, A. and White, R. (2006), *Art in the Making: Rembrandt*, 2nd edn, London, National Gallery Company: 184–9.
2. Wieseman, M. (2010), 'Rembrandt's portrait(s?) of Frederik Rihel', *National Gallery Technical Bulletin* 31: 96–111; see also http://www.nationalgallery.org.uk/upload/pdf/Wieseman_2010.pdf.
3. A campaign of macro XRF scanning of this area was undertaken subsequent to the restoration; while clarifying many features of the underlying composition the question of the identification of the first sitter remains somewhat open.
4. Wieseman 2010 (cited in note 2) p. 106.
5. Maclaren and Brown 1991 (cited in note 1) pp. 359 and 361, n. 5.
6. See Bomford *et al.* 2006 (cited in note 1) p. 184; Maclaren and Brown 1991 (cited in note 1) p. 360.
7. The pose, while evocative of such defined horsemanship practice, is not exactly as illustrated in contemporary treatises. It has also been suggested that the pose may derive from a small bronze sculpture (Walter Liedtke, personal communication, 2014).
8. See <http://amshistorica.unibo.it/54>. It is surely one of the strangest historical coincidences that the author of this work, an exiled English Royalist general, probably compiled most of it while renting the house of Peter Paul Rubens, who died in 1640. Cavendish lived there from 1648 until the Restoration in 1660; he is believed to have used Rubens's principal studio as a stable: Van Beneden, B. and De Poorter, N. (eds) (2006), *Royalist Refugees: William and Margaret Cavendish in the Rubenshuis (1648–1660)*, exh. cat., Antwerp, Rubenshuis and Rubenianum, 1 October–31 December 2006.
9. Maclaren and Brown 1991 (cited in note 1) p. 358.
10. For a history of AW2 and MS2A, and a summary of their physical properties, see <http://doctorswoodshop.com/LinkClick.aspx?fileticket=WlgpEgvssy4%3D&ta bid=74&mid=428>.
11. Van der Wetering, E. (2005), 'Rembrandt's self-portraits: problems of authenticity and function', *A Corpus of Rembrandt Paintings IV. The Self-Portraits*, Dordrecht, Springer: 96; Wieseman 2010 (cited in note 2) p. 107, n. 21.
12. Wieseman 2010 (cited in note 2).
13. Van der Wetering (2009), *Rembrandt: The Painter at Work*, rev. edn, Berkeley, University of California Press: 220–21.
14. Kuiper, L. and Hesterman, W. (1976) 'Restauratieverslag van Rembrandts Nachtwacht / Report on the Restoration of Rembrandt's *Night Watch*', *Bulletin van het Rijksmuseum* 24: 15; see also Editorial (1976), 'The *Night Watch* restored', *The Burlington Magazine* 118 (November): 731.
15. See the paper by David Peggie and Jo Kirby, in this volume.
16. Musée du Louvre, Paris, inv. no. MI 169; see also http://www.culture.gouv.fr/public/mistral/joconde_fr?ACTION=CHERCHER&FIELD_1=REF&VALUE_1=000PE008568.
17. I would like to acknowledge the assistance of Nele Bordt, former conservation fellow, for her assistance with the retouching.
18. I extend my gratitude to a large number of colleagues from the Conservation, Curatorial and Scientific departments – especially Betsy Wieseman – for the many stimulating discussions and exchanges during the course of the treatment.
19. For a comprehensive discussion see Taylor, P. (1992), 'The concept of houding in Dutch art theory', *Journal of the Warburg and Courtauld Institutes* 55: 210–32.
20. Parts of the sitter's buff jerkin also exhibit deliberate scratching into the wet paint.
21. See <https://rkd.nl/en/explore/images/128134>.
22. Rijksmuseum, Amsterdam, inv. SK-C-6; see also <https://www.rijksmuseum.nl/en/collection/SK-C-6>.

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Rembrandt's *Aristotle with a Bust of Homer* revisited: technical examination and new insights

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ABSTRACT Rembrandt's *Aristotle with a Bust of Homer* was examined and analysed to investigate the origin of a disfiguring hazy bloom, most visible in the dark paint passages that had been developing in the painting for decades. By combining the results of macro X-ray fluorescence imaging and the re-examination of photographic documentation, X-radiographs, autoradiographs and cross-section paint samples taken in earlier studies, the deterioration is attributed to the degradation of abundant smalt present throughout the paint structure. The observation that deterioration products were already present in the paint samples removed in 1980 is of critical interest in assessing the condition of the painting and how it evolved over time.



Figure 1 Rembrandt, *Aristotle with a Bust of Homer*, 144 × 136 cm, oil on canvas, signed and dated 'Rembrandt. f. 1653'. Purchase, special contributions and funds given or bequeathed by friends of the Museum, 1961. The Metropolitan Museum of Art, New York, 61.198.

Introduction

On 19 November 1961, the director of the Metropolitan Museum of Art (MMA), New York, James Rorimer, signalled his final bid with the blink of his right eye to win Rembrandt's *Aristotle with a Bust of Homer* for the museum (Fig. 1). More than 2000 people attended the auction that evening at Park-Bernet Galleries on Madison Avenue and the staggering sum paid generated much publicity and excitement. The MMA experienced record-breaking attendance when, shortly after the sale on 24 November, the painting went on view in the Great Hall, receiving over 120,000 visitors in two days.¹ *Aristotle with a Bust of Homer* is the only painting by Rembrandt in the collection acquired by purchase and is still today considered one of the museum's most significant holdings.

This well-documented painting was commissioned by the Sicilian nobleman Don Antonio Ruffo

and delivered to him in the summer of 1654.² The seven pages of references in Walter Liedtke's catalogue of Dutch paintings is an indication of its historical significance.³ Since entering the collection, the painting has been subject to technical investigations by curators, conservators and scientists from within and outside the MMA. It has been cleaned and restored twice,⁴ was included in the groundbreaking 1982 autoradiography study of Rembrandt's work,⁵ and featured prominently in the museum's 1992 exhibition *Rembrandt/Not Rembrandt*.⁶

The present study was initiated in response to changes in appearance that had been observed on the surface of the painting for decades. In the course of the investigation, photographic documentation was studied and the X-radiographs, autoradiographs and cross-sections of paint samples were re-examined with the aim of characterising possible deterioration and assessing the extent to which physical changes may have affected the visual impact of the painting.

Results and discussion

Rembrandt painted *Aristotle* on a canvas support which currently measures 144 × 136 cm. In the past questions were raised as to whether the painting retained the original dimensions, based primarily on interpretations of historical inventories in which the dimensions are listed in *palmi*, an Italian measurement of uncertain proportions.⁷ The presence of a selvage along the left edge of the support confirms that the width is completely original.⁸ Examination of an X-radiograph of the whole painting, recorded in 2006, reveals that cusping is present along the entire perimeter. In the X-radiograph, the fabric of the original support is obscured to a degree by the fabric of an early lining which was attached with a lead-containing adhesive.⁹ Portions of this adhesive were partially removed in a subsequent relining, accounting for the dark, less radio-opaque patches along the perimeter. The fabric weave of the original support and that of the lining support are clearly distinguishable. In Figure 2, the cusping of the original support is indicated on a digital image after close scrutiny of the actual X-radiographic plates. The technical evidence strongly suggests that the painting is very close to its original dimensions and, at the most, may have

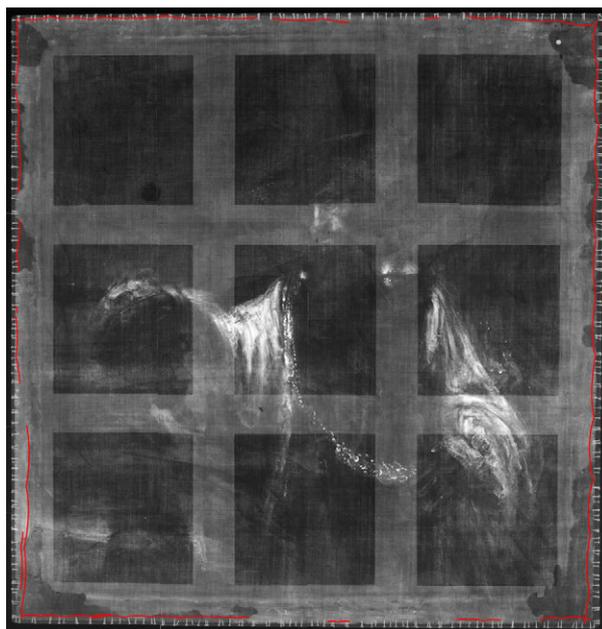


Figure 2 Rembrandt, *Aristotle with a Bust of Homer*: X-radiograph. The red line indicates the cusping of the fabric support. © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.

been reduced by only a small amount at the bottom of the composition since the cusping is only slight along the bottom edge.

Examination of photographic documentation of the conservation treatments that were carried out after the painting entered the collection, as well as photographs taken over the years by MMA photographers, was crucial to this study. In 1963, just two years after it was acquired, the painting was cleaned by Hubert von Sonnenburg.¹⁰ By 1980, a hazy bloom had developed which interfered with its appearance, prompting another cleaning that was carried out by John Brealey.¹¹ A comparison of before and after treatment photographs demonstrates that the bloom was no longer apparent after the painting had been cleaned and given a fresh coat of varnish (Fig. 3). By 1995, however, only 15 years after its last restoration, the haze-like bloom had returned, appearing as a distinct shape emerging in the background at the right just above Aristotle's elbow.

One suggestion for the origin of the surface bloom in *Aristotle* made soon after it was observed was the possible deterioration of smalt in the paint layer.¹² Smalt is a blue pigment composed of potassium silicate glass coloured by cobalt ions. Smalt pigment found in paintings dating from the sixteenth to the eighteenth century typically contains significant



Figure 3 Rembrandt, *Aristotle with a Bust of Homer*: (left) before and (right) after cleaning, 1980.



Figure 4 Rembrandt, *Aristotle with a Bust of Homer*: condition record, 2014 (left), and seventh autoradiograph (right) revealing the distribution of arsenic from smalt. The red arrows point to features discussed in the text. © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.

amounts of other elements such as arsenic, iron, nickel and bismuth.¹³ Examination of one of the autoradiographs from the 1982 study, the seventh in a series of nine (Fig. 4), revealed the distribution of arsenic in the painting, which was interpreted as being due to the presence of smalt in the painting.¹⁴ The distinct shape created by the distribution of this

element corresponded precisely with the shape that was observed developing as a haze on the surface of the painting. As Rembrandt evolved his composition, he tried out various features and made a number of changes. The shape revealed in the seventh autoradiograph was just one indication of various ideas abandoned by the artist as the composition evolved.¹⁵

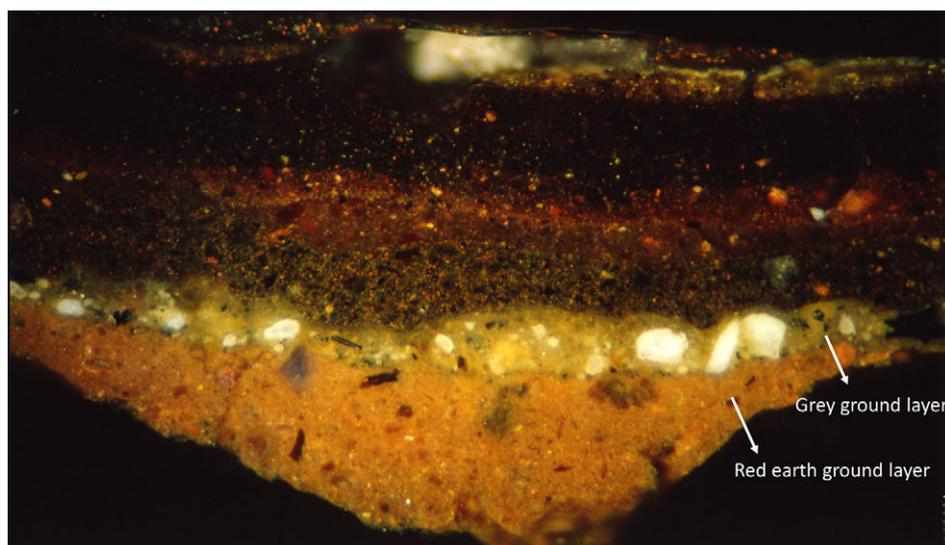


Figure 5 Rembrandt, *Aristotle with a Bust of Homer*: photomicrograph of a sample removed from the tablecloth in the lower left of the painting, mounted as a cross-section revealing the double layer structure of the ground preparation. In this ground, the first (orange-red) layer is composed of red earth, and the second (grey) layer contains lead white, a little chalk, bone black, brown and yellow ochre, umber (EDX, Raman spectroscopy). Original magnification $\times 250$. © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.

We have interpreted this correspondence as critical evidence that points to the likely deterioration of smalt in the underlayers.

Rembrandt's prolific use of smalt was noted in the 1982 autoradiography study.¹⁶ Our records on file in the MMA Department of Paintings Conservation include a report by Joyce Plesters, formerly Principal Scientific Officer at the National Gallery in London, who had been invited by John Brealey to examine and sample the painting after he had cleaned it in 1980.¹⁷ Plesters, working with Ashok Roy, former director of Collections and head of the Scientific Department at the National Gallery, who had carried out microscopy and spectrographic analyses of the samples, reported a remarkable abundance of smalt in many places, in quantities not observed in any previous investigation. The possibility of carrying out the present study was facilitated by Roy, who generously agreed to lend 11 cross-sections from the Plesters and Roy investigation that were on file in the National Gallery scientific archives. Re-examining these cross-sections was most valuable since it avoided the need for further sampling. There were two further samples from *Aristotle* in the archives of the Paintings Conservation Department at the MMA, one of which is discussed below.

A sample removed from the lower right of the red tablecloth, mounted and prepared as a cross-section,

revealed a double ground preparation (Fig. 5).¹⁸ The first layer of this ground, which was applied directly onto the canvas support, is orange-red and composed mainly of a red earth. The second thinner grey layer contains lead white, a little chalk, bone black and some earth pigments. This double ground is characteristic of those reported in many paintings by Rembrandt.¹⁹ All the pigments – identified in this study by Raman spectroscopy and scanning electron microscopy coupled with elemental analysis using energy dispersive X-ray spectrometry (SEM–EDX) on the cross-sections²⁰ – are consistent with pigments that have been reported widely in the literature in other works by Rembrandt. His unique and complex layering of combinations of opaque and translucent pigments included red and yellow lakes, carbon-based black, iron-containing earths, vermilion and frequently copious quantities of smalt. Rembrandt exploited the optical properties of these pigments when building up his paint layers in order to achieve rich translucent effects.²¹

Rembrandt's abundant use of both red and yellow lake is apparent in all the samples analysed for this study. High performance liquid chromatography (HPLC) analysis carried out on a sample removed from the lower left of the tablecloth in *Aristotle* identified a dye derived from cochineal in the red lake.²² SEM–EDX determined that the substrate in

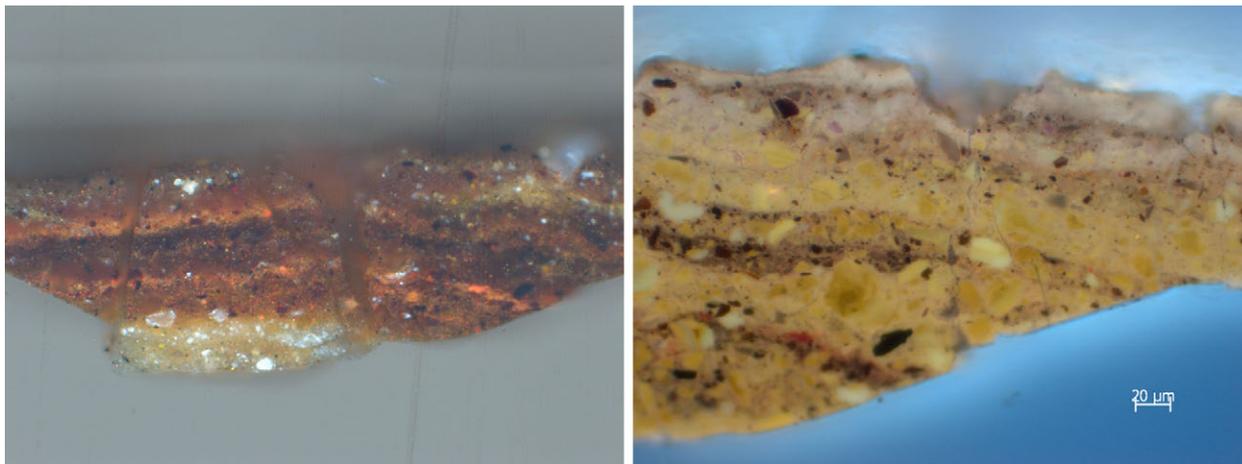


Figure 6 Rembrandt, *Aristotle with a Bust of Homer*: photomicrographs of sample 15 removed from Aristotle's hat, mounted as a cross-section, in visible (*left*) and UV (*right*) illumination. The photomicrograph on the left displays a complex layering of translucent and opaque pigments including a yellow lake, a cochineal lake, a red iron earth, a carbon-based black, lead white and smalt (EDX, Raman spectroscopy). In the photomicrograph on the right, the yellow lake particles fluoresce bright yellow. Original magnifications $\times 200$ and $\times 400$, respectively. © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.

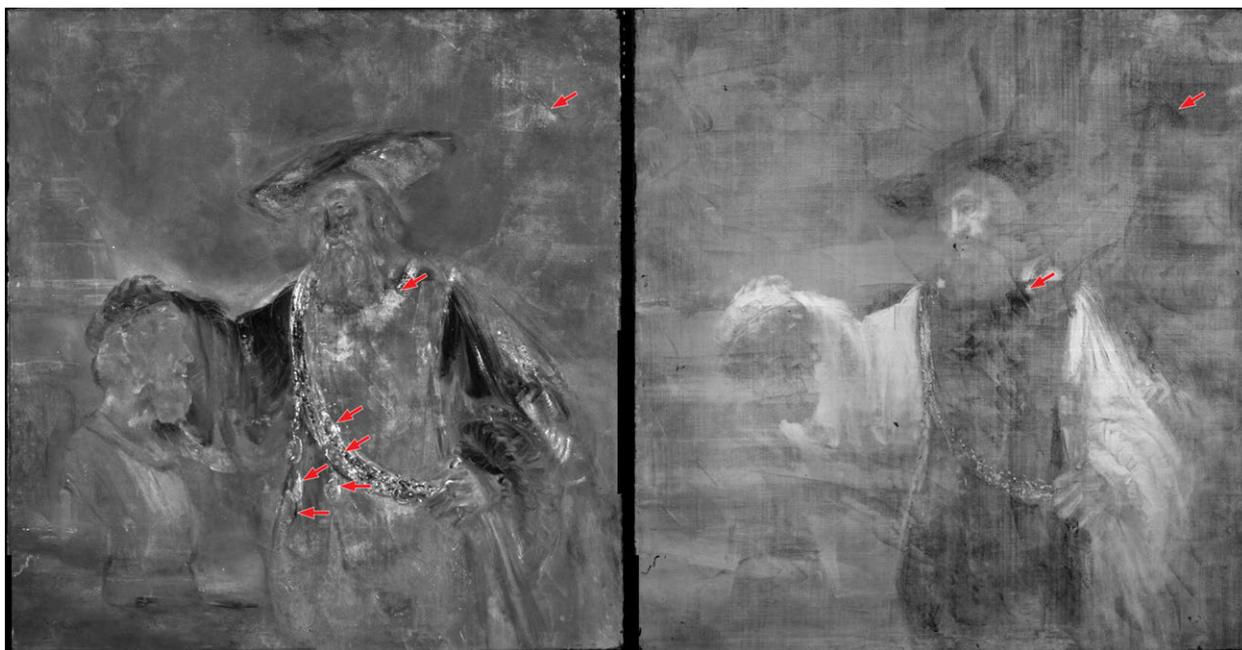


Figure 7 Rembrandt, *Aristotle with a Bust of Homer*: iron distribution map (*left*) and lead distribution map (*right*), both acquired by XRF imaging. The red arrows point to an area where the iron in the ground preparation is more visible due to thinner areas of application of the lead-containing layer on top, and to changes in the positions of the gold chain and medals. © The Department of Scientific Research, The Metropolitan Museum of Art, New York.

this red lake contains aluminium.²³ When some of the cross-sections were viewed under illumination in ultraviolet light, spectacular large particles that fluoresced bright yellow were observed (Fig. 6). SEM–EDX analysis showed that the components of these particles appear to be mainly organic and that significant amounts of aluminium are present, indicating strongly that these are a yellow lake pigment

and that an aluminium compound forms the substrate. Two samples removed as scrapings – one from the red tablecloth containing particles of what appeared to be a yellow lake, and one from Aristotle's apron skirt just below the bottom edge of the picture and possibly containing an orange-yellow lake – were analysed in 1995 by Jo Kirby at the National Gallery, London, using HPLC, but



Figure 8 Rembrandt, *Aristotle with a Bust of Homer*: eighth autoradiograph showing the distribution of phosphorus from the bone black pigment (*left*) and calcium distribution map acquired by XRF imaging (*right*). © The Department of Scientific Research, The Metropolitan Museum of Art, New York.

the precise identity of these yellow lake pigments remained elusive.²⁴ The firm identification of yellow lakes in paint cross-sections is also difficult. A laser ablation Raman technique has been used to confirm red anthraquinone lakes²⁵ but to date the technique has been unsuccessful with regard to the identification of yellow lakes localised in paint cross-sections.

X-ray fluorescence (XRF) mapping or imaging, developed at the University of Antwerp and the Delft University of Technology,²⁶ is a powerful technique that complemented other technical analyses we carried out to find answers to the questions raised during this study. While the X-radiograph revealed the artist's characteristic sweeping spatula marks resulting from the use of this tool to apply the second grey ground, a lead distribution map acquired by XRF mapping²⁷ provided a more detailed image of this upper ground layer (Fig. 7). In the iron distribution map of the lower ground application, light passages register in locations where the lead-containing second layer in the ground is thinly applied or missing. XRF imaging reveals these features in the ground preparation as complementary images. It is also apparent that multiple changes were made to the positions of the gold chain and medals, which are revealed as a result of the iron content of the yellow earth pigments used to paint these objects.

It is well known that Rembrandt made frequent changes to his compositions during the painting process. In the case of *Aristotle*, some of these design transformations were revealed by the 1982 autoradiography study.²⁸ When the full sequence of autoradiographs was considered, various stages in the modification of Aristotle's costume were noted, but the exact evolution in design proved too complicated to determine with the available data. The eighth autoradiograph, which reveals the presence of phosphorus in the bone black pigment, clearly shows an early idea for a dark tunic with close-fitting sleeves that extends to the bottom edge of the picture plane (Fig. 8). The presence and distribution of bone black can also be evaluated from the distribution of calcium in the corresponding XRF map. In the case of *Aristotle*, this distribution map provides a more readable image of some of the changes to the costume, including a shorter divided tunic and a much clearer image of the hat (Fig. 8). Because calcium is an element that emits radiation of relatively low energy, the XRF distribution map will only record the presence of bone black when used by the artist in the upper layers.²⁹ Since we were concerned with questions of condition, particularly in relation to the complex paint layer structure observed in the cross-sections in addition to the elemental distribution maps, the cross-sections from



Figure 9 Rembrandt, *Aristotle with a Bust of Homer*: photograph taken in 2014 (left), and distribution map for cobalt from the pigment smalt, acquired by XRF imaging (right). The red arrows point to the location of the area of hazy bloom developing on the surface of the painting. © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.



Figure 10 Rembrandt, *Aristotle with a Bust of Homer*: the locations of the 17 samples removed during the Plesters study in 1980. The red arrows point to the seven samples analysed for the present study.

these areas were scrutinised in order to investigate further the speculative assessments developed during earlier investigations with regard to artist changes.³⁰ The location of the bone black pigment in the layer structure was confirmed by Raman spectroscopy and

SEM–EDX analysis of these cross-sections, which helped to confirm that the final length of the tunic extended to the bottom of the composition and that Rembrandt originally intended the finished colour of both the hat and the tunic to be black.

In the cobalt distribution map (Fig. 9), which records the presence of smalt, the short divided tunic revealed in the calcium distribution map is even more sharply defined. For the purpose of this study, the cobalt map is perhaps the most valuable new image. The passages rich in cobalt and the shape defined in the background at the right should be noted in particular. When viewing the painting in its present condition, the hazy bloom can just be seen across the whole surface, but the very specific faint shape that is developing in the background to the right on the surface of the painting corresponds precisely to the shape displayed in the cobalt distribution map.

Six of the 17 cross-sections from the study by Plesters, which were removed from points now shown to contain cobalt by XRF imaging, were selected for analysis by SEM–EDX and Raman spectroscopy (Fig. 10). The results demonstrated that the layers rich in smalt are lower down in the paint stratigraphy. Analysis of sample 7 (Fig. 11) from the lower area of the tunic showed that the top layer contains mainly bone black together with some red iron oxide

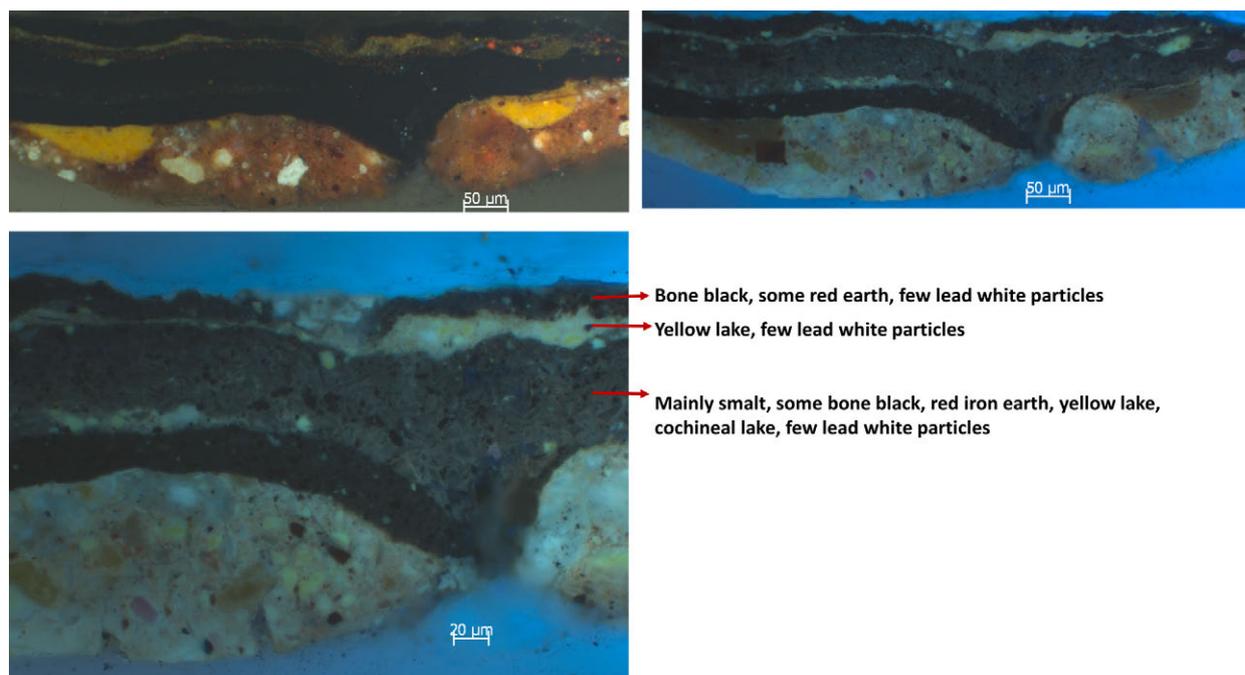


Figure 11 Rembrandt, *Aristotle with a Bust of Homer*: photomicrographs of sample 7, removed from the lower area of Aristotle's tunic, mounted as a cross-section. Photographed in visible light (top left, original magnification $\times 200$) and UV light (original magnifications: top right $\times 200$ and bottom $\times 400$). © The Department of Paintings Conservation, The Metropolitan Museum of Art, New York.

earth and a few particles of lead white. Below is a layer containing a yellow lake with a few particles of lead white under which is a relatively thick layer, rich in smalt, which also contains a cochineal lake, a red iron oxide earth, yellow lake and carbon-based black. This mixture of pigments suggests that the colour was intended to be dark and translucent but, despite the abundance of smalt, it was certainly not meant to be blue. In all the samples with paint layers containing large quantities of smalt, similar pigment mixtures were observed. It seems likely that the smalt was added in this case for translucency, in combination with red, yellow and black, to achieve a deep rich brown.

Supporting this conclusion is the SEM–EDX analysis of the paint cross-sections which confirmed that the cobalt oxide (CoO) content of the smalt used by Rembrandt in *Aristotle* was between 2 and 3 percent by weight, indicating a pale smalt. In the seventeenth century, many grades of smalt were available that varied in colour depending on their particle size and cobalt content, ranging from barely coloured to brilliant blue.³¹ In this case, Rembrandt used a smalt pigment with a barely perceptible blue colour, so any speculation of colour change due to degradation and subsequent discoloration of brighter blue smalt is

untenable. In addition, the presence of an uppermost paint layer containing primarily bone black confirms that the tunic was intended to be a deep black and, as mentioned above, originally extended to the lower edge of the picture plane.

Analysis and SEM imaging of a sample removed from a smalt-rich area in the lower right of the painting has contributed to an understanding of the degradation phenomena that are taking place in the painting. This sample contains some relatively large smalt particles allowing detailed elemental analysis by EDX. The SEM images of sample 17 (Fig. 12) revealed that the potassium content in some smalt particles decreases from the core to the periphery, indicating that potassium has leached out of the particles while their cobalt content has remained approximately constant.

The process of smalt deterioration has been studied by numerous researchers in different institutions.³² Results from these studies have shown that the decrease in alkali content within the smalt particles as a result of leaching of potassium induces a change in the coordination geometry of the cobalt ions from tetrahedral to octahedral, leading to the loss of the blue colour in the pigment, and that at the same time important structural modifications

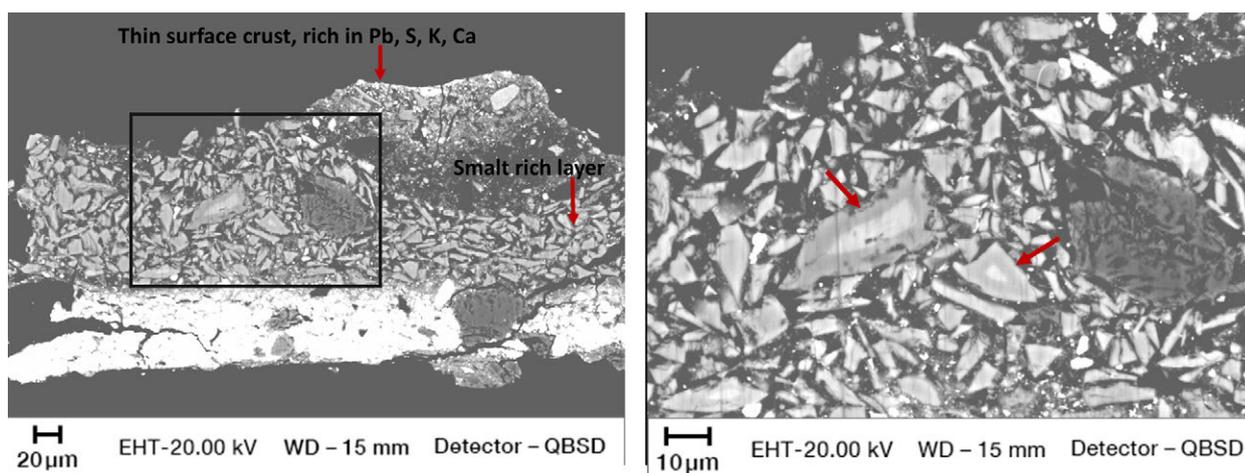


Figure 12 Rembrandt, *Aristotle with a Bust of Homer*: backscattered electron SEM images of sample 17, removed from Aristotle in the background, lower right, mounted as a cross-section. The image on the right was taken in the area indicated by a rectangle in the image on the left. The red arrows in the image on the right point to large smalt particles where potassium is preserved in the core (brighter areas) and has leached from the perimeter. Original magnifications $\times 800$ and $\times 2000$, respectively. © The Department of Scientific Research, The Metropolitan Museum of Art, New York.

occur in the smalt silicate network. It has also been proposed that these reactions are responsible for changes in the physical properties of the paint films and for the darkening of the oil medium. It has been shown that potassium that has leached from the particles reacts with free fatty acids in the oil binding medium to form potassium soaps, and that migration processes also take place that result in the formation of salt crusts on the surfaces of paintings. In addition, the composition of these crusts may be modified further by reaction with environmental contaminants.

A very thin layer observed at the top of sample 17 (Fig. 12) was found by SEM–EDX to be composed of lead, sulfur, potassium and calcium. The molecular composition of this surface layer was below the detection limit of *in situ* Raman spectroscopy; a synchrotron radiation (SR)-based technique is required to identify fully the materials present.³³ However, from the results of the SEM–EDX analysis, it is possible to propose that this surface crust probably contains a complex compound, or a mixture of compounds, involving sulfate, lead, potassium and calcium ions. It seems likely that the cause of the recurrent hazy bloom is the continuous formation of these products. Our observation that these degradation products were already present in the paint samples removed in 1980 is of critical interest in assessing the condition of the picture and how that may evolve over time.

Conclusions

The significant benefits of gaining new information from existing technical documents, cross-sections and non-invasive analyses provided by XRF imaging should not be underestimated. As with all investigations, although some questions are answered, more are raised. Analysis by a SR-based technique of the sample cross-sections taken in the past from the affected paint passages is necessary to understand the phenomenon more fully. It is hoped that insights gained from this new investigation will contribute to finding the best possible solution for the preservation and presentation of such an important and popular work by Rembrandt in the Metropolitan Museum of Art's collection.

Acknowledgements

We are indebted to Giulia Olmeda, who at the time of the project was a visiting graduate student from the Università degli Studi di Padova, for her assistance with XRF mapping measurements. We wish to thank Evan Read, Manager of Technical Documentation, Paintings Conservation Department, The Metropolitan Museum of Art, for assistance with preparing the digital images for publication.

Notes and references

1. Phillips, M. (1961), '42,000 view costliest Rembrandt at Metropolitan', *New York Times*, 19 November 1961: 1; 'The solid-gold muse', *Time*, 24 November 1961: 52.
2. Backer, J.-F. (1925), 'Les tracas judiciaires de Rembrandt', *Gazette des beaux-arts*, ser. 5, II: 50–60.
3. Liedtke, W. (2007), *Dutch Paintings in the Metropolitan Museum of Art*, vol. II, New Haven and London, Yale University Press: 646–53.
4. The painting was cleaned and restored by Hubert von Sonnenburg in 1963 and by John Brealey in 1980.
5. Ainsworth, M.W., Brealey, J., Haverkamp-Begemann, E. and Meyers, P., with the assistance of Groen, K., Cotter, M.J., Van Zelst, L. and Sayre, E.V. (1982), *Art and Autoradiography: Insights into the Genesis of Paintings by Rembrandt, Van Dyck, and Vermeer*, New York, The Metropolitan Museum of Art.
6. Von Sonnenburg, H. and Liedtke, W. (1995), *Rembrandt/Not Rembrandt in The Metropolitan Museum of Art: Aspects of Connoisseurship*, New York, The Metropolitan Museum of Art.
7. Kirby, J. (1992), 'A note on the seventeenth-century "palmo" in the context of Don Antonio Ruffo's Collection', *The Burlington Magazine* 134 (May): 297–98; Giltaij, J. (2005), 'Nieuws omtrent Ruffo en Rembrandt', *Kroniek van het Rembrandhuis* 1–2: 47–9.
8. We wish to acknowledge Petria Noble's contribution to this observation which was made in 2006 when the painting was examined in connection with research being carried out on Rembrandt's *Homer*, inv. no. 584, Mauritshuis, The Hague.
9. The lead-containing adhesive and open-weave relining fabric visible in the X-radiograph of *Aristotle* is similar to the structure revealed in the X-radiograph of Rembrandt's *Homer* (inv. no. 584, Mauritshuis, The Hague). Petria Noble carried out a technical examination of *Homer* in 2001–2006 in which she identified the relining adhesive as red lead and speculated that this lining may have been attached in Italy after the paintings were damaged in the 1783 earthquake.
10. Hubert von Sonnenburg was a conservator in the Department of Paintings Conservation at The Metropolitan Museum of Art, New York, from 1959 to 1972 and again from 1989 to 2004.
11. John Brealey was a conservator in the Department of Paintings Conservation at The Metropolitan Museum of Art, New York from 1975 to 1989.
12. The distinct shape manifesting as bloom on the surface of the painting, and the possible association with the deterioration of smalt, was first noted by conservator Dorothy Mahon.
13. Spring, M., Higgitt, C. and Saunders, D. (2005), 'Investigation of pigment–medium interaction processes in oil paint containing degraded smalt', *National Gallery Technical Bulletin* 26: 56–70; Spring, M., Kugler, V. and Bean, S. (2012), 'Quantitative energy dispersive X-ray analysis of the blue pigment smalt in the variable pressure scanning electron microscope', in *Historical Technology, Materials and Conservation: SEM and Microanalysis*, ed. N. Meeks, C. Cartwright, A. Meek and A. Mongiatti, London, Archetype Publications in association with the British Museum: 114–22; Robinet, L., Spring, M., Pagès-Camagna, S., Vantelon, D. and Trcera, T. (2011), 'Investigation of the discoloration of smalt pigment in historic paintings by micro-x-ray absorption spectroscopy at the Co K-edge', *Analytical Chemistry* 83(13): 5145–52.
14. Ainsworth *et al.* 1982 (cited in note 5) 9–11.
15. *Ibid.*, 51–2.
16. *Ibid.*, 102.
17. Unpublished report in the National Gallery Scientific Department files by Joyce Plesters, dated 9 October 1998. Ashok Roy prepared and examined the cross-sections and carried out the analyses described in this report.
18. This sample corresponds to one of the two cross-sections housed in the archives of the Paintings Conservation Department at the MMA. The second sample was not from an area that corresponded to the focus of the present investigation.
19. Groen, K. (2005), 'Grounds in Rembrandt's workshop and in paintings by his contemporaries', in Van der Wetering, E. (2005), *A Corpus of Rembrandt Paintings IV. The Self-Portraits*, Dordrecht, Springer: 318–34.
20. SEM-EDX analyses were performed with a Zeiss Sigma HD field emission variable pressure scanning electron microscope, equipped with an Oxford Instruments AZtec energy dispersive X-ray microanalysis system and an X-Max^N 80 SDD detector. EDX analyses and element mapping were carried out in a high vacuum on carbon-coated samples at an accelerating voltage of 20 kV and 8.5 mm working distance. Raman spectra were recorded with a Renishaw System 1000 spectrometer using a 785 nm laser. The laser beam was focused on different spots in the paint sample cross-sections using a ×50 objective lens. Powers in the order of 1–5 mW were used, with accumulation times of 40 seconds.
21. Bomford, D., Roy, A. and Brown, C. with contributions from Kirby, J. and White, R. (1988), *Art in the Making: Rembrandt*, London, National Gallery Company: 21–33; Von Sonnenburg and Liedtke 1995 (cited in note 6) vol. I, 31–7.
22. HPLC analyses were carried out by Dr Nobuko Shibayama, Research Scientist, Department of Scientific Research, The Metropolitan Museum of Art, in 2010.

23. Phipps, E. (2010). 'Cochineal red: the art history of a color', *The Metropolitan Museum of Art Bulletin* (Winter): 35, 37, 48.
24. Kirby, J. (1995), 'HPLC analysis of dyestuffs: Rembrandt, *Aristotle Contemplating the Bust of Homer*', unpublished analytical report sent to Hubert von Sonnenburg 4 June 1995.
25. Cesaratto, A., Leona, M., Lombardi, J.R., Comelli, D., Nevin, A. and Londero, P. (2014), 'Detection of organic colorants in historical painting layers using UV laser ablation surface-enhanced Raman microspectroscopy', *Angewandte Chemie International Edition* 53: 1–6.
26. Alfeld, M., Janssens, K., Dik, J., De Nolf, W.G. and Van der Snickt, G. (2011), 'Optimization of mobile scanning macro-XRF systems for the in situ investigation of historical paintings', *Journal of Analytical Atomic Spectrometry* 26(5): 899–909; Alfeld, M., Pedroso, J.V., Van Eikema Hommes, M., Van der Snickt, G., Tauber, G., Blaas, J., Haschke, M., Erler, K., Dik, J. and Janssens, K. (2013), 'A mobile instrument for in situ scanning macro-XRF investigation of historical paintings', *Journal of Analytical Atomic Spectrometry* 28(5): 760–67.
27. The XRF instrument used consists of a measuring head that is moved across the painting surface by means of a motorised X-Y stage with a maximum travel range of 80 × 60 cm. The measuring head includes a 30 W Rh-target micro-focus X-ray tube and a silicon drift detector (SDD) to collect the fluorescence signal. The X-ray source was operated at 50 kV and 500 mA, and the resulting beam focused by means of a polycapillary optic. The A Z motor allowed the spot size to be optimised to the step size by varying the distance between the painting and the measuring head. The overall painting was scanned at 150 msec/pixel with a 1 mm step size. Smaller areas including the head of Aristotle and the lower part of the tunic were also analysed with 800 and 750 µm step sizes respectively, and at 300 msec/pixel. The spectra were processed through dynamic analysis employing a combination of Pymca and Datamuncher software as described by Alfeld, M. and Janssens K. (2015), 'Strategies for processing mega-pixel X-ray fluorescence hyperspectral data: a case study on a version of Caravaggio's painting *Supper at Emmaus*', *Journal of Analytical Atomic Spectrometry* 30: 777.
28. Ainsworth *et al.* 1982 (cited in note 5) 51–2.
29. Noble, P., Van Loon, A., Alfeld, M., Janssens, K. and Dik, J. (2012), 'Rembrandt and/or studio, *Saul and David*, c.1655: visualising the curtain using cross-section analyses and X-ray fluorescence imaging', *Technè* 35: 36–45.
30. Plesters 1998 (cited in note 17).
31. Spring *et al.* 2012 (cited in note 13).
32. Spring *et al.* 2005 and 2012 (cited in note 13); Robinet *et al.* 2011 (cited in note 13); Boon, J., Keune, K., Van der Weerd, J., Geldof, M. and Van Asperen de Boer, J.R.J. (2001), 'Imaging microspectroscopic, secondary ion mass spectrometric and electron microscopic studies on discoloured and partially discoloured smalt in cross-sections of 16th century paintings', *Chimia* 55: 952–60.
33. Price, S.W.T., Van Loon, A., Keune, K., Parsons, A.D., Murray, C., Beale, A.M. and Mosselmans, J.F.W. (2019), 'Unravelling the spatial dependency of the complex solid-state chemistry of Pb in a paint micro-sample from Rembrandt's *Homer* using XRD-CT', *Chemical Communications* 55: 1931–4.

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Karin Groen, Rembrandt scholar: a tribute

Ian McClure¹

It is a particular honour to be asked to give a tribute to my late colleague and friend Karin Groen (Fig. 1). Many readers may know of Karin through her published work, were taught by her or had the great good fortune to collaborate with her on research projects. Some may also have known her as a great personal friend, whose death in 2013 after a short and severe illness came as a profound shock and drew many to the moving ceremony in September 2014 at the University of Amsterdam to mark the publication of her collected writings.² For readers who are less familiar with her life and work, this paper offers a picture of one of the great figures in the field of technical art history, active well before this term became current, and who combined perceptive analytical skills and careful observation with a great love of paintings.

I first met Karin Groen in the winter of 1981 when I came down from Glasgow Art Gallery to visit the Hamilton Kerr Institute (HKI). The heating in the Mill Building there had failed and I was introduced to staff members, all wearing thick coats and scarves. Karin alone seemed to be thoroughly enjoying the situation as she showed me the laboratory and some of the projects on which she had been working. When I finally joined the staff of the HKI in June the following year, I quickly came to realise that this was my first sign of her enormous positive influence on the life of the institute: its approach to research, treatment and most importantly, in teaching and mentoring students and interns. That autumn Ella Hendriks arrived to start the three-year postgraduate diploma course in the conservation of paintings so we both came to know and work with Karin at almost the same time.

Karin left in 1990 to take up a position at Stichting Restauratie Atelier Limburg (SRAL),³ which was established by Anne van Grevenstein on similar lines to the HKI and where Karin taught until 1995. I kept in contact with her while Ella, like so many of Karin's students, went on to work closely with her as



Figure 1 Karin Groen in the garden of the Hamilton Kerr Institute c.1987.



Figure 2 Karin in her laboratory, originally Sir Hamilton Kerr's dining room.

their careers in conservation and technical research flourished. We were both honoured to be part of the defence committee when she was awarded her PhD at the University of Amsterdam in 2011 for her dissertation *Paintings in the Laboratory*.⁴

In the eight years that I worked with Karin at the HKI, a cohort of students and conservation fellows passed through and went on to distinguished careers in conservation and scientific research in conservation in the UK, Europe and the United States. Under the watchful eye of the HKI's Advisory Council that included Herbert Lank, Sir Oliver Millar, Garry Thomson, Edward Hall, Michael Jaffe and chaired by Sir Bernard Williams, even then it seemed to me to be a golden age (Fig. 2).

Karin had already acquired a considerable reputation when she was persuaded to join the HKI in 1980 by the then director, Norman Brommelle. Her career had begun in 1969 at the Central Research

Laboratory in Amsterdam,⁵ where art historians, conservators and scientists were encouraged to work closely together in the examination of works of art. This experience very much influenced her approach to teaching and mentoring at the HKI and from my arrival, I was struck by her love of, and response to, paintings, her intense interest in understanding the materials and techniques in a work of art derived from an initial close examination and only then employing her skill in analysis. I observed how warmly students under her guidance responded and how spontaneously artists' techniques and materials became the focus of discussions in the studios. Carrying her small black box containing her sampling kit, she would come to the conservation studios where, together with the student, she would study the painting at length. We worked on a wide range of paintings in terms of date and scale: from the Fitzwilliam Museum's



The Metropolitan Museum of Art
 Fifth Avenue at 82nd Street, New York, N.Y. 10028 212-TR 9-5500
 Paintings Conservation Department

Date: VII. 14. '80 By: C. Gees Object No. 20.155.2
 Object: Rembrandt Noble Slav Br. 169, Corpus II A43 Sample No. XF2 C4654
 Description of sample spot: lower left corner - from lower edge 19.5cm (w/edge) at rt. edge.
 Reason for sample taking: largeness of pigment - of all XF1

Paint cross-section	Layer No.	Thickness	Analysis (final results):
	3		SEM-layer 3 = lead, iron, Mn, little Cu? dark under.
Hypothetical structure observed under microscope:		Description of sample by stereomicroscope:	
varnish dk. grey dark grey red ground		varnish grey black grey red ground (little).	
Cross-section under microscope examination:			
5. varnish 4. lead white, ochre, (some) black, some darker brown pigment: amber 3. black pigment and some brown and lead white 2. amber ground layers: lead white, a little red ochre, lamp black 1. red earth, amber.			

Figure 3 Rembrandt, *The Noble Slav*, 1632, The Metropolitan Museum of Art, 20.155.2, New York, and Karin's record of a sample from the lower left corner.

Triptych by Filippo Lippi to George Stubbs's *Hambletonian Rubbing Down* from Mount Stewart House in Northern Ireland.

Shortly before I arrived at the HKI, Karin had turned her attention to the examination of the Fitzwilliam Museum's *Portrait of a Man in Military Costume* which had long been considered an autograph work.⁶ Her report, with its balanced and lucid description of the painting process and the results of analysis of selected cross-sections, was able to prove that the painting with its alterations was painted as a single process, not a painting placed over an earlier work, and that many aspects of the technique reflected Rembrandt's practice. The uneven execution of details of the painting raised stylistic questions and the palpably false signature suggested a workshop production or a close contemporary imitator. Karin's report was accompanied by her meticulous hand-coloured drawings of the layers in a cross-section – a practice that many of her students adopted as a way of focusing the eye and closely observing the image.

Her study of Titian's *Tarquin and Lucretia* countered Michael Jaffe's first impression that the painting had been cut at the bottom, based on the evidence of

Cornelis Cort's print of the painting made around 1570. Refuting Michael took a certain amount of courage, but he was impressed by her conclusions and they subsequently co-authored an article in *The Burlington Magazine*.⁷

It was, however, the arrival of paintings from Kingston Lacy House in Dorset which the National Trust had taken over in 1981 that dominated the work of the HKI for a number of years, providing the opportunity to study a group of paintings by Peter Lely, collected by Sir Ralph Bankes, which led to research into Lely's workshop practice and became the subject of Ella's final year research project. The house needed major repairs and while some of the paintings had suffered from neglect, including the only easel painting that I have seen attacked by dry rot, others were in wonderful condition, not least because they had been treated by a clearly sensitive conservator in the eighteenth century. The portrait of *Lady Jenkinson* was in a superb condition but had been significantly altered by Rembrandt's use of smalt, which had subsequently discoloured. Ella's project investigated the technical differences between Lely's autograph works and those made with the assistance of the workshop and workshop

copies. The research, co-authored by Karin, was later published in the HKI's second *Bulletin*.⁸

Other significant groups of paintings were also studied. In preparation for the Frans Hals exhibition held at the National Gallery of Art in Washington in 1989, and subsequently at the Royal Academy in London and the Frans Halsmuseum in Haarlem,⁹ Karin and Ella examined 40 paintings including the late *Portrait of a Man* in the Fitzwilliam Museum with its double ground, one of a variety of ground types employed by the artist which led Karin to suspect that primed canvases were sometimes obtained from different suppliers. She also examined a corpus of works by Hendrick Goltzius and Judith Leyster.¹⁰ Other collaborative publications followed, authored by Karin or hugely supported by her: on Dutch seventeenth-century flower painting; on the puzzling portrait of *Rembrandt in a Flat Cap* in the British Royal Collection; and on Godfried Schalken's unlined portrait of a man in the Fitzwilliam Museum.¹¹ She had an impressive knowledge of other Golden Age Dutch painters and created a valuable list of grounds used by different artists of the period. She also contributed to the research on Vermeer's *Girl with a Pearl Earring*, working with Jørgen Wadum and colleagues at the Mauritshuis in The Hague.

These extensive and influential studies pale beside Karin's lifelong work on Rembrandt and his workshop, and the materials and techniques that he used to create his works, culminating in her close involvement with the Rembrandt Research Project. Aware of her work at the Central Research Laboratory, soon after Ernst van de Wetering joined the Rembrandt Research team he involved Karin, and the first publications of their findings appeared in 1976 (on *The Night Watch*) and 1977 (on the young Rembrandt). Karin's published research on Rembrandt went on to span more than 30 years during which time she reviewed and modified her research, aided by close observation, experience and access over the years to increasingly sensitive analytical equipment.¹²

Around 1980, Karin undertook technical studies of a number of Rembrandt paintings in the Metropolitan Museum of Art (New York) collection for the pioneering 'Art and Autoradiography' project.¹³ Her paint samples were essential to determine in which layers the elements identified in the autoradiographs were present, helping to unravel the layered build-up of the paintings and to understand

Rembrandt's working process. Karin's drawing of one of the four samples she examined from Rembrandt's *Noble Slav* in the MMA's collection gives a sense of her attention to detail (Fig. 3). Her findings are integrated in the published entry for this painting in the *Corpus of Rembrandt Paintings*.¹⁴

In her discussion on conservation science and art history (a chapter in her PhD submission), Karin mentions the influence of Max Doerner's *Malmaterial und seine Verwendung im Bilde*, first published in 1921,¹⁵ in which he stated that Rembrandt achieved particular effects through the use of resinous media, making his paintings vulnerable to cleaning. This proposal was highly influential as can be seen in the cleaning of works by Rembrandt carried out in the 1930s. For example, the *Man in Armour* in the collection of Glasgow Art Gallery and Museums was sent to Holland to be cleaned under the personal supervision of Martin de Wild.¹⁶ He cleaned the highlights and avoided the darks. Varnish around these highlighted areas that had been swollen by solvent but not removed ultimately became hazy and blanched; this was also a feature of the cleaning of the Frans Hals' *Portrait of a Man* by Horace Buttery in 1947. When a group of late Rembrandt paintings in the Rijksmuseum was cleaned in the period 1990–98, however, Doerner's observations were largely discredited. Karin's cross-section from a shadow in the sleeve of the *Jewish Bride* showed that it consists of a transparent brown layer on top of a lead white one, yet since the brown paint does not contain resinous media, the darkened varnish on top could be safely removed.

One of her most significant contributions to our understanding of Rembrandt's technique is her study of the grounds in his paintings.¹⁷ In the Netherlands, Karin had begun to work on aspects of Rembrandt's technique, in particular an examination of *The Night Watch* and a study of his early paintings. She discovered that *The Night Watch* was a first example of the use of river clay, also employed by his fellow potters (*pottenbakkers*) in the Guild of St Luke, to prepare the canvas for use: a practice unique to Rembrandt and his workshop in the period c.1640–69. The cheap clay material provided a suitable ground colour on which to paint, and when mixed with fine sand gave a supple quality that allowed large canvases such as the *The Night Watch* to be rolled without causing the paint layers to flake. This is another



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Monsterformulier ANALYTISCHE AFDELING

Datum monstername: 24/11/1961, door: Mest, M. de Kijzer couponr. 224c
 Object: Rembrandt, Het laatste zelfportret
 Herkomst: Van Haag, Mauritshuis (p.m. 04c) dianr. 3397
 Beschrijving monsterplaats: Rechts, rechter zijhand, ± 10 cm van
 Boven, op de omhegging
 Reden monstername: obj.nr./monsternr. 120811
 dok.majnr. 01/31

Pigment (identiek aan 2 en 3?) zwart

Dwaardoornede	Laagnr.	dikte	Analyseresultaat
	3	± 0,4 μm	6 - oranje
	2	± 1,5 μm	of ligt op 3
	3	± 6,0 μm	gemiddelde laag, binnendeelsgewijs benauwd r. okes, rals tal
	2	± 2,4 μm	gemiddelde wijfslag
	1	muutl ± 5,5 μm	↑ 1-2 groen?

Hypothese bij bestudering object: in lag 4 heel goed zichtbaar laagje gaat over in de coagule

Beschrijving van het monster bij waarneming door stereomicroscoop: oranje, bruinzwart, zwart met groffe witte korrels afgedrukt doek

Resultaat microscopie:
 9 wit
 8 oranje, fluoresceert, groen
 7 wit
 6 oranje, fluoresceert, groen
 5 wit
 4 oranje, fluoresceert, groen

Resultaat micro-chemische analyse:
 Bij behandeling met rec. HCl:
 10 % HCl:
 10 % NaOH:
 conc. HNO₃:
 25 % HNO₃:

Verhitting:
 CO₂++ Pb** Hg** Sn**
 Ca** Cu** SO₄**
 Fe+++ S** Ag*

3. gemiddelde laag met rood, oranje, bruin, wit, geel, en zwart pigment (binnendeelsgewijs)
 2. bruinzwarte laag met heel weinig rood en wit pigment, matig fluorescentie, binnendeelsgewijs
 1. gemiddelde laag met rood en wit pigment, deze laag is bruiner dan laag 3 (is zwarter)

1 laag grond, blauw, mengsel, uitgesprode deeltjes, 100 μm in de meeste van de monsters.

Figure 4 Rembrandt, *Self-Portrait*, Mauritshuis, The Hague. The sample noted here was taken in 1961.

example of how, when their working properties are well understood, the straightforward use of ordinary materials – rather than ‘secret recipes’ – could enhance the skills of the artist and produce desired and stable effects.

Karin’s research was founded on studies of a wide range of works and the rapport she invariably developed with colleagues around the world gave her access to many collections. In her article in Volume IV of the *Corpus* on grounds in the Rembrandt workshop and in paintings by his contemporaries, the acknowledgements for assistance and for permission to sample give an idea of how deeply she was embedded in Rembrandt studies and how highly she was valued: the list includes the Rijksmuseum, Amsterdam, and the Mauritshuis, The Hague; the National Gallery and the Wallace Collection, London, and the Royal Collection; the Lichtenstein collection in Vaduz; the Doerner Institut, Munich, and the Gemäldegalerie, Berlin; KIK–IRPA, Brussels; the Metropolitan Museum of Art, New York, the National Gallery of Art, Washington, the Museum of Fine Arts, Boston, the Getty Museum and the Cleveland Museum of Art; and collections in Stockholm, Ottawa, Helsinki, Kassel – the list goes on.¹⁸ All Karin’s ‘sample forms’ with drawings of the Rembrandt samples she examined at what was then

the Central Research Laboratory in Amsterdam have been incorporated into the RKD Rembrandt Database, along with digital images of her paint cross-sections re-photographed at high resolution in both ultraviolet and normal light. Often the forms contain unique observations that indicate how knowledge progressed. For example, the one illustrated in Figure 4, including a note by Karin on the coarseness of the stack-process lead white particles, later became a feature of interest when studying the rheology of Rembrandt’s impasto.

Karin also was particularly interested in the effects of conservation treatments. The HKI’s science laboratory was weighted towards optical microscopy, so Karin set about developing connections throughout the rest of Cambridge University, particularly the electron microprobe in the Department of Earth Sciences, a piece of analytical equipment of doubtful reliability. In her account of her career she reported how she would sit with the *Guardian* newspaper as results were laboriously printed by dot matrix. She also gained access to the scanning electron microscope (SEM) in the Department of Material Sciences and Metallurgy, enabling her to study blanching in paintings by Claude Lorrain and Gaspar Dughet, which had been observed in the Ashmolean Museum’s *Acansus Shooting the Stag* by

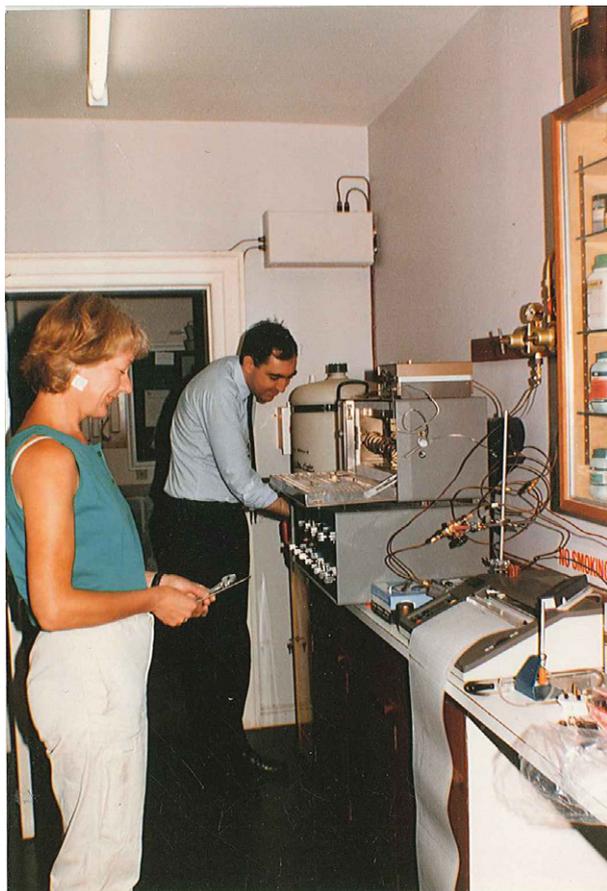


Figure 5 Karin and Raymond White coaxing an early gas chromatograph into life c.1986.

Claude and the *Landscape near Rome* by Dughet from the Fitzwilliam Museum, both treated at the HKI.¹⁹ Her research led to her observation that blanching occurred as a result of components in the paint film being leached out. Using SEM images she demonstrated that re-forming with dimethylformamide vapour irreversibly changed the structure of the paint film. We took this lesson to heart when several years later Brad Epley, now the chief conservator at the Menil Collection Houston, successfully reversed the blanching of the large landscape in the Fitzwilliam Museum by Jan Both using Regalrez 1094. Karin also possessed strong opinions that I could not easily shake. A sharp critic of any cleaning mixture containing ammonia, she would demonstrate to students how a copper tack used as a substitution for copper-based pigments such as azurite would dissolve in a 32% solution in the laboratory. Today, while most would consider the demonstration a little extreme, cleaning solutions with a high pH are avoided.

Over time more analytical equipment was added to the laboratory. An early model of a gas chromatograph (GC) was given to the HKI by the Central Research Laboratory. Expert help in the figure of Raymond White from the Scientific Department of the National Gallery was called in, and the three of us spent an evening getting the equipment to work, or more accurately, watching Raymond coax it into life (Fig. 5). One drawback in the design of this early Perkin Elmer GC model was that there was no obvious way to check that the detector flame was lit and as often it was not, hydrogen filled the oven, resulting in intermittent small explosions. Eventually a more reliable Carlo Erba gas chromatograph followed and several future conservation scientists cut their analytical teeth on it before it too was retired. When she moved to the training institute SRAL in Maastricht, typically Karin was able to develop a particularly fruitful relationship with the research laboratories of DSM, originally the Dutch State Mines, but which had diversified into a chemical and materials research company, allowing her access to a wide range of analytical equipment.

Karin maintained both her Dutch connections and those with the USA during her time at the HKI; the close ties with institutions, colleagues and past fellows continued. Often called upon to collaborate on the examination of paintings, students regularly accompanied her and on occasions I also travelled with her. Her research on Frans Hals coincided with the treatment of the Fitzwilliam Museum's late *Portrait of a Man* as well as the *The Family Group in a Landscape* then in the collection of Lord Boyne on loan to the National Museum of Wales in Cardiff. The painting is now part of the collection of the Toledo Museum in Ohio and the group has now been identified as the Van Campen family. Accompanied by Karin, I went to study the portion of the painting that had been cut off and is now in the *Musées Royaux des Beaux-Arts* in Brussels. At the end of a long day we sat in a bar in the Grand Place, overlooking the square, enjoying a beer and eggs Benedict. Karin said what I always knew would be inevitable: 'this, Ian, is what I miss.' It was good that she went on to SRAL before taking up a position back at the same institution where she had started her career, the Central Research Laboratory in Amsterdam where she continued to work until her retirement in October 2006, when she was awarded a royal medal as a mark of her outstanding professional achievements.

Although this tribute has concentrated on her major contribution to Rembrandt research – as a research colleague, author and teacher – it is not the complete picture. She was quite simply a wonderful person and always great fun to be around. She had an innate sense of style in everything she did. She was an elegant skater and from time to time in cold winters we would go skating, the uneven flooded and frozen fields of the Cambridgeshire Fens being a poor substitute for the canals around Amsterdam. She was also a keen traveller and after a trip to the west coast of Africa, managed to catch malaria despite following all the preparatory instructions. My task was to take her from the isolation ward in Addenbrookes Hospital in Cambridge and accompany her back to her house to collect belongings for her discharge. I arrived from singing in a concert dressed in a black tie and we made a grand exit from the hospital, which Karin hugely enjoyed. We also travelled together to Eaton Hall in Cheshire to inspect and courier two portraits attributed to Rembrandt back to the HKI where they were to be inspected by the Rembrandt Research Project team. The owner hoped they would be downgraded so he could save on the insurance. After visiting Moscow and the Grabar Institute on an HKI study trip to Russia, our party had a memorable overnight train journey to Leningrad (Fig. 6) as it was then called, when Karin discovered that the steward of our carriage had a supply of excellent champagne from Georgia. Later we were able to meet the senior conservator Evgeny Gerasimov at The Hermitage in St Petersburg and view the progress of the restoration of *Danae and the Shower of Gold* after it had been attacked with acid by a vandal.

In Cambridge, Karin always seemed to be zooming about in her little grey, rather beat-up Honda Civic. It made regular trips to Amsterdam where Karin found it one morning occupied by a homeless man fast asleep in the back. Far from being horrified, she found the incident both amusing and instructive. After her retirement she continued to travel widely, visiting collections and exhibitions. She visited Yale in 2010 en route from examining seventeenth-century Dutch paintings in a private collection in Florida via the National Gallery of Art in Washington and the Metropolitan Museum of Art in New York.

Karin's fascination for paintings continued right up to the end. In August 2013, despite faltering health and



Figure 6 Hamilton Kerr Institute study trip to Moscow and Leningrad. From left: Régine Page, Ann Massing, Nicola Christie and Karin Groen.

just weeks before she died, she took up Ella Hendriks's invitation to attend the exhibition *Frans Hals: Eye to Eye with Rembrandt, Rubens and Titian* outside opening hours at the Frans Hals Museum in Haarlem. As Karin toured the exhibition sharing her thoughts on the paintings, she picked up seamlessly from her earlier Frans Hals research with Ella, enjoying the opportunity of looking at the Hals paintings together and discussing them in the light of these earlier findings. Similar memories will be cherished by those who have known and had the privilege of working with Karin, whose presence we all greatly miss to this day.

Notes and references

1. An oral presentation given by both Ian McClure and Ella Hendriks.
2. Groen, K. (2014), *Paintings in the Laboratory: Scientific Examination for Art History and Conservation*, ed. E. van Duijn, London, Archetype Publications.
3. See <http://www.sral.nl/en>.
4. Groen 2014 (cited in note 2).

5. Now known as the Cultural Heritage Agency of the Netherlands (RCE).
6. Now catalogued as: Attributed to Rembrandt van Rijn, *Portrait of a Man in Military Costume*, Fitzwilliam Museum, Cambridge, Founder's Bequest 1816, acc. no.152.
7. Jaffé, M. and Groen, K. (1987), 'Titian's *Tarquin and Lucretia* in the Fitzwilliam', *The Burlington Magazine* 129: 162–72.
8. Hendriks, E. and Groen, K. (1994), 'Lely's studio practice', *Hamilton Kerr Institute Bulletin* 2: 21–37.
9. Groen, K. and Hendriks, E. (1989), 'Frans Hals: a technical examination', in *Frans Hals*, ed. S. Slive, exh. cat., National Gallery of Art, Washington, DC/Royal Academy, London/ Frans Halsmuseum, Haarlem/London, Royal Academy of Arts: 109–27.
10. Hendriks, E., Van Grevenstein, A. and Groen, K. (1993), 'The painting technique of four paintings by Hendrick Goltzius and the introduction of coloured ground', *Nederlands Kunsthistorisch Jaarboek* 42–3: 481–97; Hendriks, E. and Groen, K. (1993), 'Judith Leyster: a technical examination of her work', in *Judith Leyster: A Dutch Master and her World*, ed. J.A. Welu and P. Biesboer, exh. cat., Worcester Art Museum, Worcester, MA/Frans Hals Museum, Haarlem, Zwolle, Waanders Publishers: 93–114.
11. Murray, S. and Groen, K. (1994), 'Four early Dutch flower paintings examined with reference to Crispijn de passe's *Den Blom-Hof*', *Hamilton Kerr Institute Bulletin* 2: 6–20; Groen, K. (1988), 'The examination of the *Portrait of Rembrandt in a Flat Cap*', *Hamilton Kerr Institute Bulletin* 1: 66–8; Massing, A. and Groen, K. (1988), 'A self-portrait by Godfried Schalken', *Hamilton Kerr Institute Bulletin* 1: 105–8.
12. Van de Wetering, E., Groen C.M. and Mosk, J.A. (1976), 'Summary report on the results of the technical examination of Rembrandt's *Night Watch*', *Bulletin van het Rijksmuseum* 24: 68–98; Groen, K. (1997), 'Investigation of the use of the binding medium by Rembrandt', *Zeitschrift für Kunsttechnologie und Konservierung* 11: 207–27; Groen, K. (2005), 'Grounds in Rembrandt's workshop and in paintings by his contemporaries', in Van der Wetering, E. (2005), *A Corpus of Rembrandt Paintings IV. The Self-Portraits*, Dordrecht, Springer: 318–34.
13. Meyers, P., Ainsworth, M.W. and Groen, K. (1982), 'Pigments and other painting materials', in *Art and Autoradiography: Insights into the Genesis of Paintings by Rembrandt, Van Dyck and Vermeer*, New York, The Metropolitan Museum of Art.
14. See www.rembrandtdatabase.org.
15. Doerner's book was highly influential. See, for example, the translation by Eugen Neuhaus (1949), Max Doerner, *The Materials of the Artist and their use in Painting*, New York, Harcourt Brace: 89,151, 188 and 370.
16. See, for example, the article 'The Man in Armour': a loan to Holland', *Glasgow Herald*, 7 October 1930: 8.
17. Groen 2014 (cited in note 1) 51–66.
18. *Ibid.*, 21–49.
19. Groen, K. (1988), 'Scanning electron microscopy as an aid in the study of blanching', *Hamilton Kerr Institute Bulletin* 1: 48–65.

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The use and identification of red lake pigments in paintings by Rembrandt

David A. Peggie and Jo Kirby

ABSTRACT Rembrandt commonly used lake pigments within mixtures to add warmth and colour to darker passages of paint. Analysis has shown that he employed red lakes derived from several sources, usually cochineal and madder but also brazilwood, as discovered in the *Portrait of Frederick Rihel on Horseback*. Brazilwood lakes are initially strongly coloured with hues ranging from pink to purple but eventually degrade to a dull yellowish-brown. Their presence is frequently only confirmed by detection of a ‘marker’ component, the exact identity of which has been confirmed recently. A further aspect of particular interest is that light exposure does not appear to be the sole factor in the deterioration of brazilwood-derived lakes and experiments conducted at the National Gallery in London indicate that an alkaline environment during pigment manufacture may increase the rate of degradation. Greater understanding of these issues will improve our ability to recognise this highly fugitive pigment and inform discussions on the extent of any changes in the appearance of a particular work upon ageing.

Introduction: lake pigments and the identification of their source

Throughout his long career – from his precocious and colourful early works as a young painter in Leiden to his elegiac and sometimes enigmatic late works – Rembrandt demonstrated a mastery over the use of paint. Like other seventeenth-century artists, he often constructed the image he was painting initially through the modelling of light and shade in the underpaint or so-called dead-colouring layers of the composition, followed by the application of colour to create the volume of the figures, the depth of an interior or another setting for the figures. One property of the pigments that can contribute considerably to the sense of depth and space in the painting is their relative opacity or translucency in the binding medium used which, for Rembrandt and most of his contemporaries, was generally oil. Pigments such as vermilion and lead-tin yellow, bright and opaque in an oil medium, are typically used as foreground

colours or to provide highlights; more translucent pigments, such as the blue glass pigment smalt, or a range of red and yellow lake pigments, can be used more flexibly. These lake pigments were integral to Rembrandt’s palette, often utilised to add translucency and warmth in complex mixtures or to reinforce the colour of otherwise duller ochres in opaquely painted passages.¹ However, lake pigments are prone to fading more than other pigment types, potentially altering the appearance of passages of paint and making it more difficult to understand the artist’s intention.

This paper considers Rembrandt’s use of red lake pigments generally while introducing a more detailed study of a specific type of lake pigment derived from brazilwood. Lakes are a particular category of pigment for which the source of the colour is a natural dyestuff of plant or animal origin. Both red and yellow lake pigments have been used throughout the history of painting and in the seventeenth century the yellow dyestuffs employed for pigment

manufacture were all extracted from plant species including weld (*Reseda luteola* L.), dyer's broom (*Genista tinctoria* L.), the unripe berries of buckthorn (*Rhamnus* species) and various dye woods. The red dyes were extracted from species of scale insect such as Mexican cochineal (*Dactylopius coccus* Costa), the roots of the madder plant (*Rubia tinctorum* L.) and heartwood from the so-called 'soluble redwoods': sappanwood (*Caesalpinia sappan* L., now *Biancaea sappan* (L.) Tod.) from Southeast Asia and several South American species, commonly called brazilwoods (including *Caesalpinia brasiliensis* L. and *Caesalpinia echinata* Lam., now *Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis), were all imported into Amsterdam in the seventeenth century.

In the simplest route to manufacture, the soluble dyestuff was extracted from the material directly as in the case of all the lake pigments made from yellow dyes and the red lakes produced from the soluble redwoods (for convenience, the name brazilwood will be used to refer to all these woods: all contain the same principal dye constituents). For lakes derived from the scale insect dyestuffs and madder, an indirect method involving extracting the dyestuff components from textile shearings was often used.² The organic colorants obtained from extraction were then precipitated onto an insoluble support, generally an alumina hydrate formed through the reaction of alum with an aqueous alkali to produce the pigment. In the case of the yellow lakes and the brazilwood-derived pigments, the support often incorporated a calcium salt such as chalk (calcium carbonate) as well as the alumina produced during the precipitation reaction.

Regardless of whether the predominant inorganic support was hydrated alumina or calcium-containing salts, the red or yellow lake would be translucent when mixed with the oil painting medium, and it is this, together with the relatively high tinting strength of the red pigments in particular, that made lakes especially useful to artists. Furthermore, the use of lakes derived from different biological sources and manufactured using various recipes provided a range of translucent colours from which the artist could choose. When cochineal is used as the dye source, for example, an intense crimson-coloured paint is obtained, while a lake derived from madder root will produce a paint that is more orange-red in colour.

Brazilwood-derived lakes can vary in colour quite considerably depending on the exact method of manufacture, with hues ranging from pink through to a strong, almost vermilion red, and more purple shades (see below).

When lake pigments are observed in paint samples, the inorganic support and organic colorants (dyestuff components) generally require to be investigated using different analytical techniques. Identification of the elements contributing to the substrate, such as aluminium and calcium, is often achieved using scanning electron microscopy with energy dispersive X-ray (SEM-EDX) analysis, while the biological sources from which the lake pigments are derived can be investigated by detecting the dyestuff components with high performance liquid chromatography (HPLC). However, successful identification requires a sufficient quantity of the lake pigment to be present in a sample and this is complicated by Rembrandt's routine use of lakes in highly heterogeneous pigment mixtures (as discussed below). In cases such as these, only a relatively small proportion of a sample consists of the lake and obtaining a positive identification of the dye source is therefore extremely challenging.

Another taxing feature in regard to the analysis of pigments derived from natural organic colorants is that, as a class, they are more or less fugitive and prone to fading. Therefore, particles of both cochineal- and madder-derived lake pigments that have undergone pronounced degradation will have a slightly 'washed-out' red appearance when examined using visible light microscopy. Nevertheless, in paint samples containing complex pigment mixtures these will still be recognisable as particles of red lake. In addition, although there is less original dye present in the faded particles than there would be in unfaded particles, HPLC analysis may still provide clues to the identity of the biological source provided that some colour remains and the lake pigment constitutes a sufficiently high proportion of the sample. If degradation is severe, however, the particles become colourless and a positive HPLC result is very much harder to obtain.

Brazilwood-derived lake pigments, on the other hand, seem to behave slightly differently during degradation. The pigment particles are initially strongly coloured, with hues ranging from pink to purple, but these turn a yellowish-brown colour upon

Table 1 Dye sources of lake pigments used in paintings by Rembrandt from the National Gallery, identified using HPLC.

NG no.	Title (date)	Sample description	Dye source
6432	<i>Portrait of Hendrickje Stoffels</i> (1654–56)	Deep crimson of tablecloth	Cochineal + madder
1674	<i>Portrait of Jacob Trip</i> (1661)	Brown glaze on mid-brown fur	Cochineal
		Red glaze (site unknown)	Cochineal + madder
1675	<i>Portrait of Margaretha de Geer, Wife of Jacob Trip</i> (1661)	Brown glaze from the background	Cochineal (trace)
6300	<i>Portrait of Frederick Rihel on Horseback</i> (probably 1663)	Brownish underlayer below yellow of Frederick Rihel's coat	Cochineal + brazilwood
221	<i>Self Portrait at the Age of 63</i> (1669)	Glaze on sleeve of plum-coloured coat	Cochineal + madder + yellow lake (buckthorn?)

degradation before eventually losing their colour completely. This colour change is particularly problematic because it increases the possibility that the presence of degraded brazilwood lake in a sample might be missed during microscopic examination – the particles might be mistaken instead for a yellow lake. It is often difficult to confirm the presence of a yellow lake in a paint sample using HPLC since the dyestuffs utilised in the manufacture of yellow lakes are generally even more fugitive than the reds, therefore sufficient organic colorant to obtain a positive result is present only in very favourable circumstances. This situation is not helped by the fact that degraded brazilwood can only be recognised by the presence of a 'marker' component, recently identified as urolithin C, using HPLC.³ A reliable interpretation of the visual function of a passage of paint, and thus the artist's intention, relies on a thorough understanding of the pigments used in the paint mixture: the ability to identify a brazilwood lake, even in its faded, yellowish-brown state, and to determine why and how brazilwood lakes degrade, is thus of considerable importance.

HPLC analysis of lake pigments used by Rembrandt

The different dye sources identified from lakes used in Rembrandt's paintings from the National Gallery (NG) in London are summarised in Table 1. As mentioned above, analysis of the lakes by HPLC

requires enough lake pigment of interest to be present in a paint sample. Particles of red and yellow lake pigments have frequently been observed in paint cross-sections using visible light microscopy, but obtaining a sample with sufficient quantity of lake to provide a positive identification by HPLC is often difficult. Therefore, the relatively small number of results should not be taken as a statistical representation of the number of occurrences, which are likely to be far more widespread than implied by Table 1.

The results shown here clearly indicate the predominance of cochineal-derived red lakes. Sometimes cochineal was the only source observed in the sample, but on other occasions Rembrandt used both cochineal- and madder-derived pigments together. There is one case of red brazilwood-derived lake (used with cochineal lake) and one positive identification of a yellow lake, probably derived from unripe buckthorn berries and used in a mixture with both cochineal and madder.⁴

It is significant that positive identifications have been obtained for both a brazilwood-derived red lake and a yellow lake, although these occur in different paintings. The confirmation that both red and yellow lakes were used by Rembrandt underlines the importance of being able to distinguish degraded brazilwood lake particles from a yellow lake, thus enabling the pigment mixtures observed in cross-sections to be correctly interpreted even when an additional sample is not available or if an insufficient quantity of lake is present in the sample for analysis by HPLC.

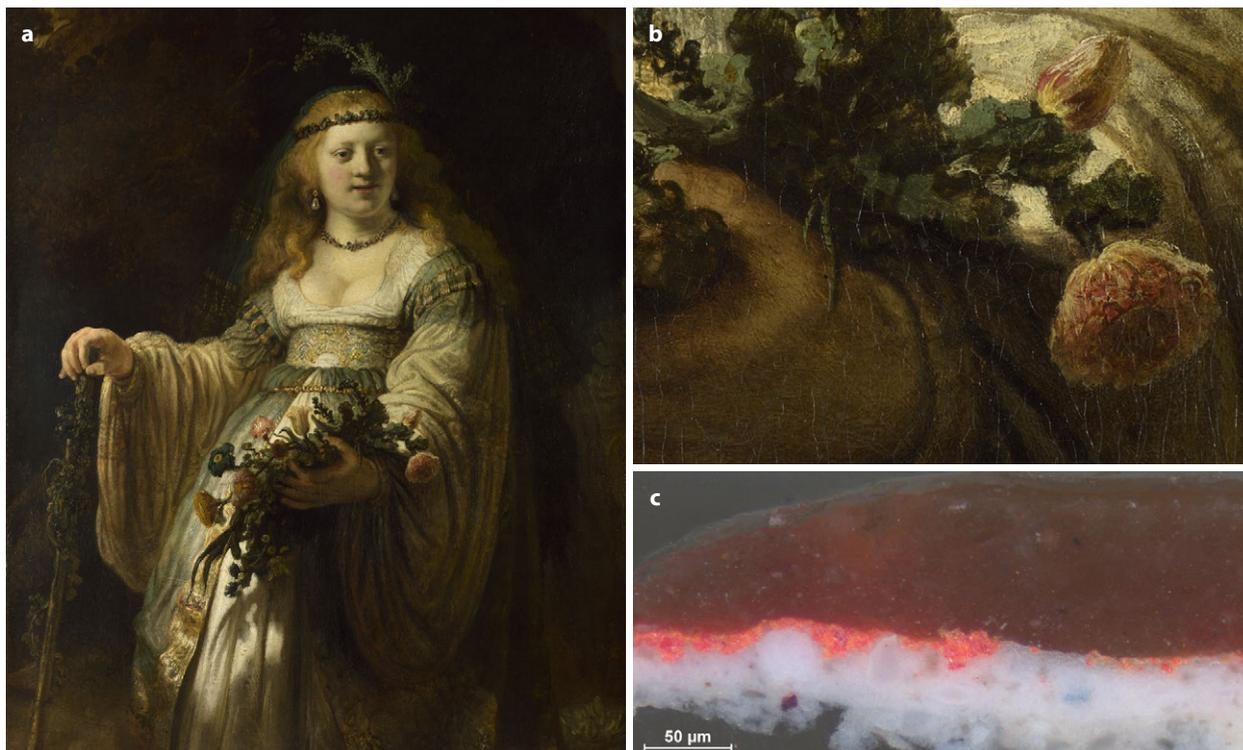


Figure 1 (a) Rembrandt, *Saskia van Uylenburgh in Arcadian Costume*, 1635, oil on canvas, 123.5 × 97.5 cm, National Gallery, London (NG4930); (b) detail; (c) the cross-section shows that the red of the rose was painted using a layer of translucent lake pigment over vermilion. Photo © The National Gallery, London.

Rembrandt's use of lake pigments

Examination of a number of cross-section samples from the NG's Rembrandt paintings using visible and ultraviolet light microscopy indicated that both red and yellow lake pigments were integral to his palette,⁵ employed in a variety of ways. Red lakes on their own occasionally functioned as transparent glaze paints, for example, but more commonly red and yellow lakes were used in complex mixtures to add translucency and warmth to the paint. They were added to browns containing red earths, blacks or smalt, for instance, or to reinforce the colour of otherwise duller ochres in opaquely painted passages. Although the precise layer structure and composition of the lake-containing samples varies considerably, they can be grouped into a few broad categories. A representative selection of samples, taken largely during studies of the paintings in 1987–88 for the exhibition *Art in the Making: Rembrandt*, are described below.⁶

Red lakes were traditionally used for richly coloured transparent glazes over opaque underlayers and Rembrandt also employed lakes in this way. In

Saskia van Uylenburgh in Arcadian Costume, the dark red of the rose in the bouquet, for example, is underpainted in vermilion then simply glazed with a thick layer of translucent red lake pigment (Fig. 1a–c).⁷ More commonly, however, Rembrandt added lakes to mixtures. These could be relatively simple, such as that used for the opaque red highlight marking the edge of the tablecloth in the *Portrait of Hendrickje Stoffels* (Fig. 2a and b), which is painted with a thick streak of pure orange-red ochre mixed with a small amount of transparent red lake, intensifying and 'lifting' the highlight.⁸ It is interesting to note that, as in the red in Saskia's bouquet, a thick red lake-containing glaze layer was used to depict the deep crimson tablecloth, this time over an opaque brown underlayer. Analysis has shown that in this uppermost glaze layer Rembrandt utilised both the crimson-coloured cochineal and the more orange-red madder-derived lake, allowing subtle modulations of the red tones while maintaining the depth and richness provided by the lake pigments.

The use of red lake pigments in a more complicated mixture is also observed in the *Portrait of Hendrickje Stoffels*. A sample from the lower left edge

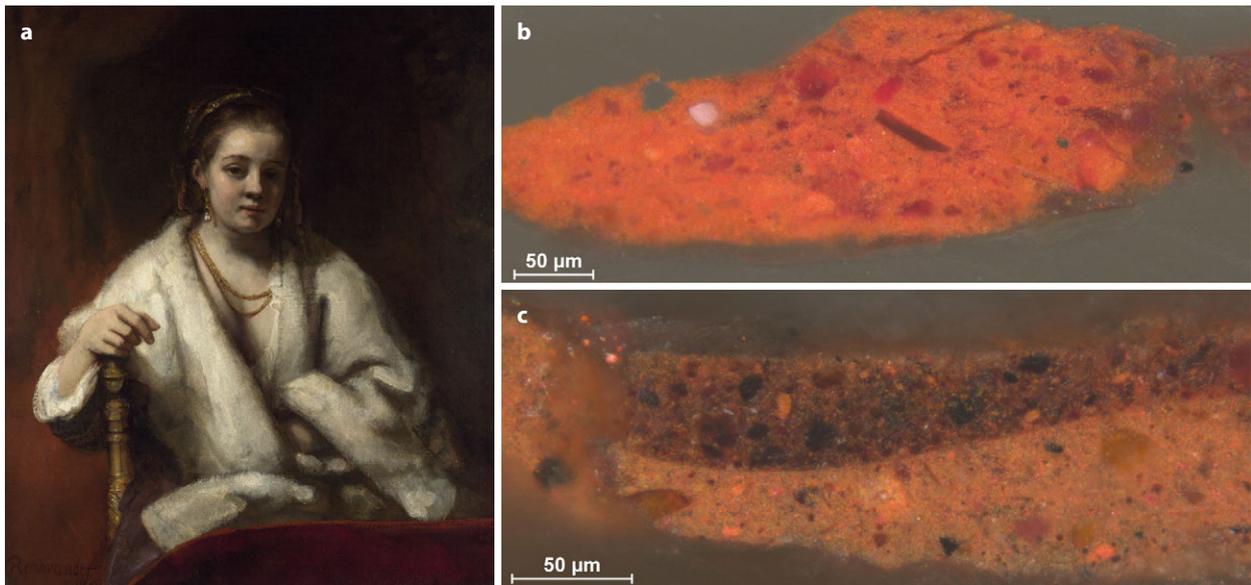


Figure 2 (a) Rembrandt, *Portrait of Hendrickje Stoffels*, probably 1654–56, oil on canvas, 101.9 × 83.7 cm, National Gallery, London (NG6432); (b) this cross-section, taken from the opaque red highlight that marks the edge of the tablecloth, shows a small amount of transparent red lake mixed with an orange-red ochre; (c) this cross-section, taken from the warm brown background towards the lower left of the composition, shows how lake pigments were mixed with ochres and black in both the upper and lower layers. Photo © The National Gallery, London.

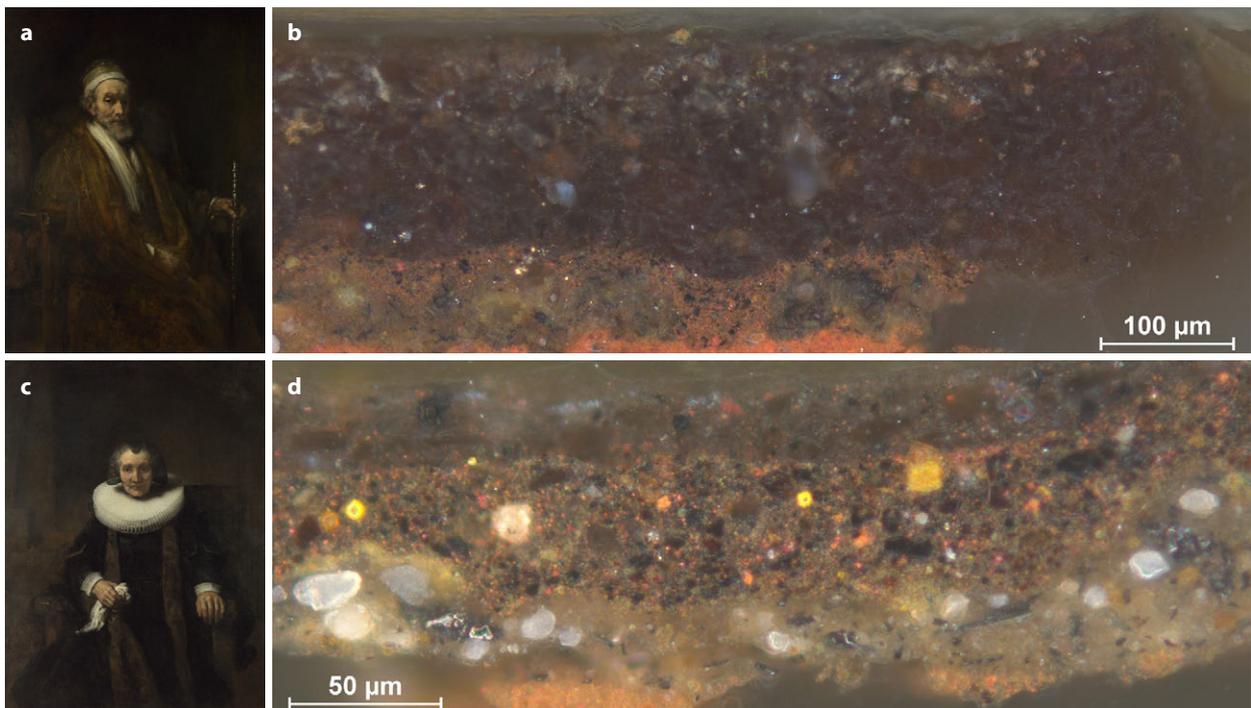


Figure 3 (a) Rembrandt, *Portrait of Jacob Trip*, c.1661, oil on canvas, 130.5 × 97 cm, National Gallery, London (NG1674); (b) this cross-section was taken from the brownish-red chair cushion on which Jacob Trip sits. The lower orange layer of the double ground can just be seen below the greyish upper ground layer (discontinuous). This is then followed by a layer composed mainly of red earth and bone black pigments before a very thick orange-brown layer of smalt, mixed with red lake. The particles of red lake are difficult to discern due to the deterioration of smalt. (c) Rembrandt, *Portrait of Margaretha de Geer, Wife of Jacob Trip*, c.1661, oil on canvas, 130.5 × 97.5 cm, National Gallery, London (NG1675); (d) this cross-section was taken from the background at the left-hand edge of the painting. Again, the lower orange layer of the double ground is just observable below the greyish upper ground layer. This is then followed by a highly heterogeneous brown underlayer composed mainly of earths, black and possibly a little lake and an upper layer containing mainly smalt, but mixed with black, red earth and possibly some lake pigment. Photo © The National Gallery, London.

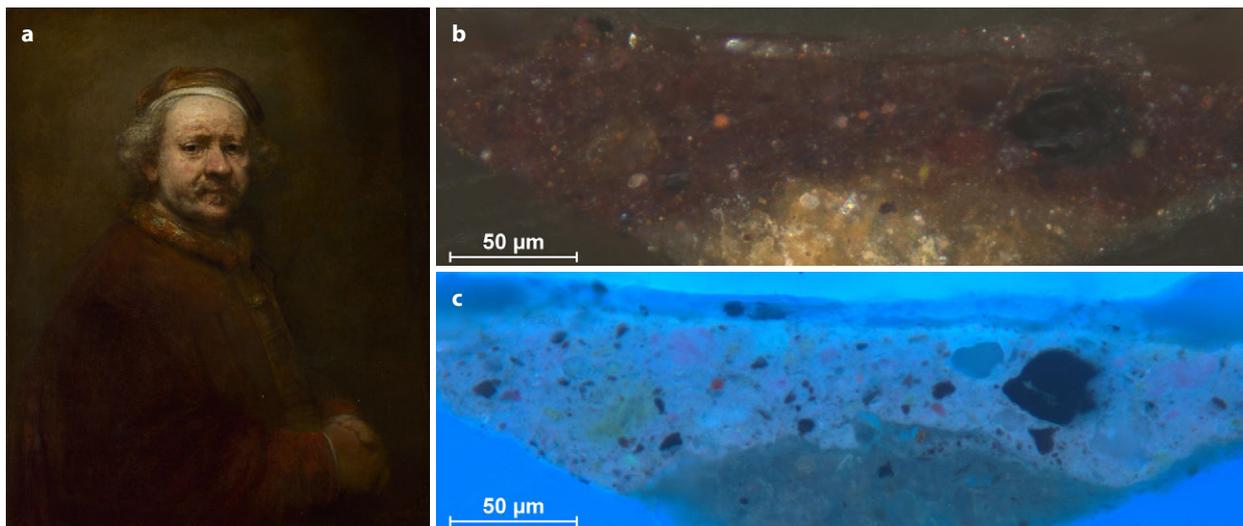


Figure 4 (a) Rembrandt, *Self Portrait at the Age of 63*, 1669, oil on canvas, 86 × 70.5 cm, National Gallery, London (NG221); (b) a cross-section taken from the coat showing the warm translucent tones prepared using a lake-containing mixture intensified with black; (c) both red and yellow lake particles are apparent when the cross-section is illuminated using ultraviolet light. Photo © The National Gallery, London.

(Fig. 2c) shows that the warm brown background colour was painted in two layers: the more opaque orange-brown lower layer consists of a mixture of red and yellow ochres with some red lake pigment, a little black and what appears to be a yellow lake. There is no supporting chromatographic analysis, but the translucent brownish-yellow coloured particle towards the upper right-hand side of the lower layer has the optical characteristics of a yellow lake. The upper layer contains similar pigments although it has a much higher proportion of black and is richer in colour and more translucent due to the higher proportion of lake pigment present, which also provides a depth and warmth to the paint passage.

Many of the translucent browns and reds observed in the *Portrait of Jacob Trip* and *Portrait of Margaretha de Geer* (the pendant to *Jacob Trip*) were prepared slightly differently in that they also contain the blue pigment smalt.⁹ This translucent pigment made from ground glass deteriorates in oil, significantly altering the colour of the paint – partly due to loss of colour in the pigment particles themselves and partly because of alterations in the binding medium caused by the leaching of alkali from the glass.¹⁰ This discoloration can make it difficult to observe the presence of any additional pigments within the paint layer except in thin cross-sections by transmitted light.¹¹ Furthermore, the overall visual appearance of any smalt-containing paint passages will have changed markedly over time, making interpretation

of the artist's intention in these areas particularly challenging when viewing the works today.

Paint samples taken from both the *Portrait of Jacob Trip* and the *Portrait of Margaretha de Geer* suggest that modulation of the red and brown tones in many of the smalt-containing passages was at least partially achieved by varying the quantities of red lake, earths and bone black. A sample from the left edge of the *Portrait of Jacob Trip* (Fig. 3a and b), taken from the reddish-brown coloured cushion of the sitter's chair, reveals a thick upper layer of paint containing a relatively simple mixture of a little red lake together with a large amount of smalt, perhaps suggesting that the cushion was originally rather cooler in colour than it appears today.

A sample from the background of the *Portrait of Margaretha de Geer* (Fig. 3c and d), taken from an area at the left-hand edge of the composition depicting a grey-brown architectural feature, contains a more complex mixture. As in the example from the *Portrait of Jacob Trip* (Fig. 3a and b), the uppermost paint layer would have been translucent, containing mainly smalt, but this time mixed with black, red earth and possibly some red lake pigment. The presence of a small amount of red lake would have helped to adjust the tonality of the paint while maintaining its translucency, allowing Rembrandt to create subtle colour distinctions between different regions of the background. Additionally, the colour of the lower paint layer would have played

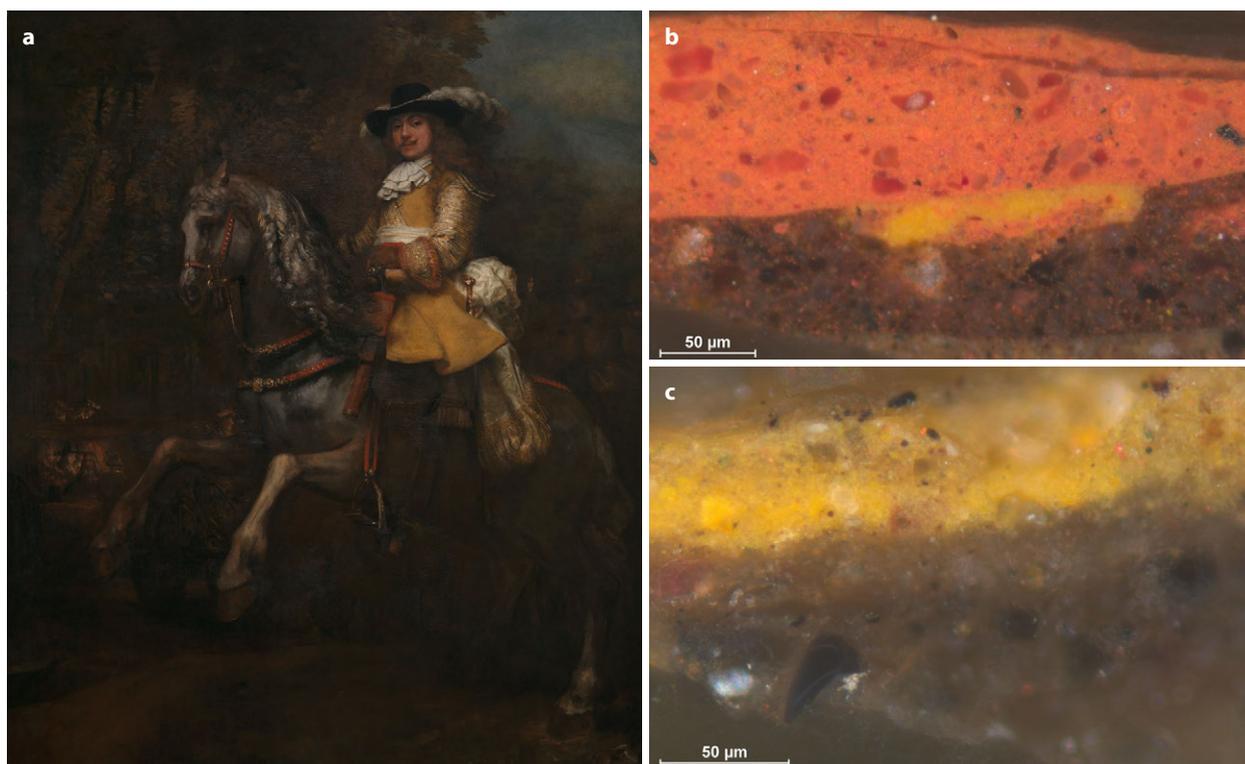


Figure 5 (a) Rembrandt, *Portrait of Frederick Rihel on Horseback*, probably 1663, oil on canvas, 294.5 × 241 cm, National Gallery, London (NG6300); (b) this cross-section was taken from the stirrup strap and shows an upper paint layer consisting mostly of red earth mixed with a little red lake pigment. Below this is a streak of yellow within a warm brown-coloured layer that also contains red lake; (c) this cross-section was taken from the yellow impasto fringe of the sash. Beneath the two yellow layers composed mainly of yellow ochre are two layers of smalt mixed with a little earth, black and lake pigments. The smalt has deteriorated making interpretation difficult, but the brazilwood lake appears to be present in these lower layers. Photo © The National Gallery, London.

a significant role in establishing the overall tonality in these passages due to the translucency of the upper layer.

It is clear from these examples that red lakes were integral to Rembrandt's palette, as in the case of his *Self-Portrait at the Age of 63*, where a lake-containing mixture intensified with black was employed to give a wide variety of rich, warm translucent tones to the modelling of the coat (Fig. 4a–c).¹² While it is interesting to note that both the crimson-coloured cochineal lake and the more orange-red coloured madder lake were used to create the reds of the sleeve, the most significant finding from HPLC analysis was the detection of some yellow lake, probably derived from unripe buckthorn berries.

Although many of the archive samples of paint from Rembrandt's works re-examined during this study appear to contain particles of yellow lake, indicating that yellow lakes were often a component of Rembrandt's mixtures, confirmation (by HPLC) of the botanical source of the dye present in these lake

pigments is particularly difficult to obtain. This is due primarily to the fact that the yellow lakes were employed mainly in small quantities within the pigment mixtures, but their tendency to degrade is often also a factor. However, results of HPLC analysis from Rembrandt's *Self-Portrait at the Age of 63* confirm that both yellow and red lakes were used within the same passage of paint. In contrast, results obtained from the *Portrait of Frederick Rihel on Horseback*, where a similar mixture was initially thought to have been used, confirmed the presence of cochineal together with a degraded brazilwood-derived lake which had turned a yellowish-brown colour.

Rembrandt used many of the red lake-containing mixtures described above in his portrait of Frederick Rihel. For example, the impasto paint employed for the red of the stirrup strap contains red earth and red lake over a series of warm brown-coloured underlayers, which also contain red lake in much the same way as used for the red highlight of the *Portrait of Hendrickje Stoffels* (Fig. 5a and b).¹³ Examination by X-radiography

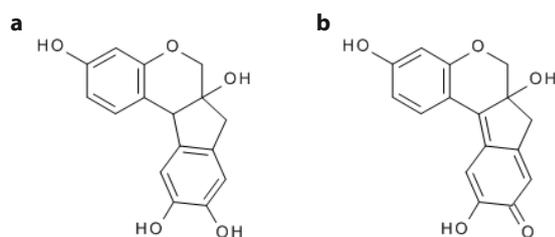


Figure 6 Brazilin and the conjugated structure, brazilein, the principal colorant in both the Old and New World species of soluble redwood.

and scanning X-ray fluorescence (XRF) has confirmed that the portrait of Frederick Rihel was painted over another composition.¹⁴ Paint layers from this earlier composition contribute to the layer structure observed in cross-sections and this needs to be borne in mind when interpreting these paint samples.¹⁵ The yellow-coloured impasto fringe of the sash (Fig. 5c) is depicted using two layers consisting mainly of yellow ochre, but beneath this are two layers of paint comprising mainly smalt, with some earths, black and lake pigments and further paint layers below these.

A cross-section made from a sample taken from the yellow coat revealed a similar structure to that obtained from the yellow sash, with both smalt and lake pigments present underneath an opaque yellow ochre-containing layer. The appearance of a thin cross-section prepared from this paint sample suggested that the brownish-coloured lower layer might contain a yellow lake together with a crimson red lake, easily observed in the cross-section. However, when a sample from this area was analysed by HPLC no yellow lake was found – instead a cochineal-derived lake was identified together with the marker component for a degraded brazilwood lake, now known to be urolithin C. This finding was unexpected for two reasons: the appearance of the cross-section had not suggested the presence of a brazilwood-derived lake and the lake had degraded to a yellow-brown colour, despite being situated below an opaque yellow paint where it would not have been exposed to light. Confirmation that Rembrandt used a brazilwood-derived lake is particularly interesting since lakes of this type are rarely observed in easel paintings, perhaps partly because they deteriorate. It is therefore worth exploring in more detail lakes of this type before introducing some of the issues surrounding their degradation and detection.

Brazilwood dye sources and lake recipes

Brazilwood is the generic term for a group of soluble redwoods belonging to the same botanical tribe (Caesalpinieae – family Fabaceae; subfamily Caesalpinioideae).¹⁶ The major source of the dyestuff from the Middle Ages until the discovery of the New World was sappanwood which grows in many areas of Asia from where it was imported into Europe. The discovery of the New World led to a large abundance of similar redwoods being found and exploited for their dyestuff.¹⁷ Indeed, the importance of this trade from the New World can be seen in the fact that the term describing the fiery red colour obtained from the wood, *brasa* (glowing coals) was also used to derive the name given by the Portuguese to the country they had conquered: Brazil. Although studies have identified various components from the heartwood,¹⁸ the main source of colorant in both the Old and New World sources is brazilin, which when oxidised produces the conjugated structure, brazilein (Fig. 6).

In the seventeenth century, soluble redwoods from South America (pernambuco wood and others) together with sappanwood from Asia, were being imported into Amsterdam in large quantities.¹⁹ The trees would have required at least 8–10 years of growth before felling in order to extract sufficient dye from the heartwood, which was traded in the form of logs that were then cut into chips and pounded in mortars before extraction of the dye components. This was particularly harsh work and by the early seventeenth century prisoners in Holland were being forced to undertake this task as ‘hard labour’ in the Rasphuis, reducing the brazilwood logs to sawdust in preparation for dyeing and lake making. Remarkably, even employing prisoners could not make this profitable once windmills were granted permission to grind dyewoods.²⁰

In contrast to many of the recipes for cochineal- and madder-derived lakes, brazilwood lake pigments were not prepared from cloth shearings but produced directly from the wood. The colouring matter is easily extracted into water, dilute acids or alkalis and the ease with which pigments could be made and the range of colours that could be obtained, from pinks to fiery reds to purples, are indicated by the large number of recipes for their preparation, from

all parts of Europe, from medieval times on. Many of these were for inks and other pigments originally intended primarily for use in the production of manuscripts. Nevertheless, the recipes fall into two broad categories, depending on whether or not the colorant is first extracted into an alkaline solution.

In the first type, the dye was extracted by heating shavings of the wood in an alkaline solution (from weakly alkaline urine to much stronger alkalis such as those prepared from wood ash, essentially potassium carbonate). The addition of potash alum to the filtered solution caused the precipitation of the dye on an amorphous hydrated alumina substrate. The colour varied from a purplish crimson to a rich reddish purple, or even chestnut brown, depending on the conditions. In the second type, the dye might be extracted in water, vinegar or wine, followed by the addition of alum; in other words, the dye was in an acidic solution. Many of the earlier recipes of this class relate to bright red inks; however, the addition of a wood ash alkali precipitated a bright scarlet pigment, also on an amorphous hydrated alumina substrate. In fourteenth–sixteenth-century sources, there are fewer recipes for this variety of brazilwood pigment than for those in which the dye is extracted into alkali and then alum added. Alternatively, a calcium salt such as chalk, crushed eggshells or cuttlefish bone, all of which are composed of calcium carbonate, could be added to the alum-containing solution, often in large quantities as an extender. The pigment produced, known as *roset* (*roosen* or *rosen* in Dutch)²¹ was bright pink in an aqueous medium such as gum or glue, the shade depending on the amount of extender present, and a bright red in oil medium.

Versions of these essentially medieval recipes continued to be copied in seventeenth-century sources of the popular ‘secret book’ type. An example is the *Secreet-Boeck van vele diversche en heerlicke consten in veelderleye materien*, compiled by Carel Baten (Carolus Battus) and first published in Dordrecht in 1591, with further editions appearing in 1609 and throughout the seventeenth century until 1694.²² Baten reproduced recipes from sixteenth-century works such as the *Illuminirbuch* by Valentin Boltz von Rufach (Basel 1549) and the well-known ‘secrets’ book of Alessio Piemontese, which had several Dutch language editions.²³ However, although the essential chemical principles of the recipes (the addition



Figure 7 A page from the Pekstok papers describing the implements required for the manufacture of a red lake pigment: a copper kettle to boil the sappanwood or brazilwood; a basket which acts as a sieve to catch the wood after it has been boiled; and a barrel to collect the water, now containing the dye. This water is then transferred to a tub, where additional ingredients are added and the resulting pigment is left to settle. The three plugs on the left of the tub are used to drain the clear supernatant water once the pigment has settled to the bottom. Also illustrated are a spade for stirring, a bucket to scoop the pigment from the tub and chalk stones upon which to lay the pigment out to dry. De Pekstok-notities, entry no. 15030 inv.nr. 77900 (ZKW 4D 6), 1691/Amsterdam City Archives.

of alum to an alkali or vice versa) remain valid and would have been followed by seventeenth-century pigment makers, it is very uncertain that these actual recipes remained in use.

Although supporting documentary evidence is somewhat scarce, the technology of red lake pigment manufacture may have changed gradually during the seventeenth and early eighteenth century, reflecting developments in both chemistry and chemical technology.²⁴ A rare source of information is provided by the workshop notebook probably copied out by Pieter Pekstok, the son of the Amsterdam colour-seller and

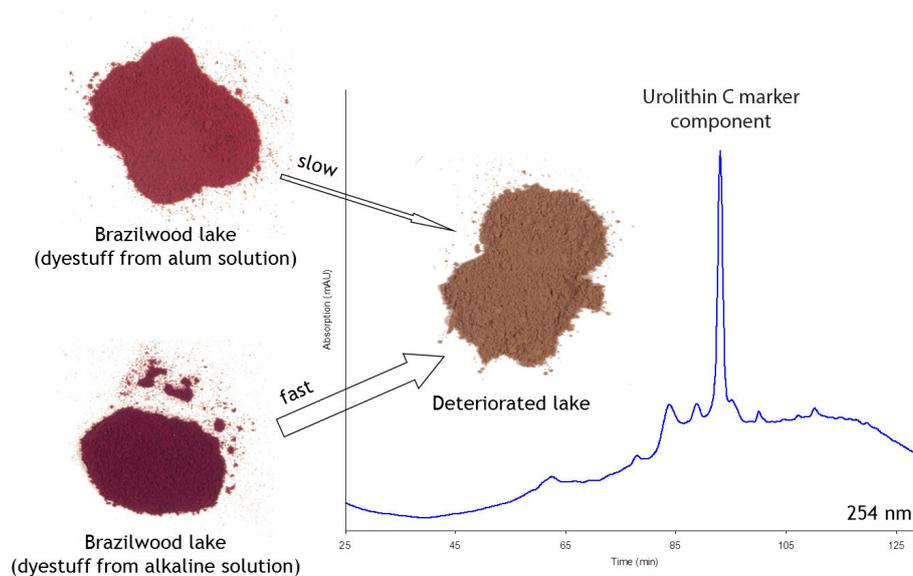


Figure 8 Reference brazilwood-derived lakes display a range of colours when freshly produced depending on the recipe followed. However, the lakes deteriorate, even when stored in the dark, and those made from an alkaline solution appear to do so at a faster rate than those produced using the ‘acid first’ methods. The brazilwood marker component urolithin C was present when the deteriorated lakes were analysed by HPLC while most of the brazilein had degraded. Photo © The National Gallery, London.

manufacturer Willem Pekstok (1634/35–1691). The so-called Pekstok papers²⁵ are well known for their detailed description of vermilion manufacture, but they also contain descriptions of the production of both red and yellow lake pigments, verdigris and sealing waxes, the distillation of turpentine and the manufacture of vinegars, illustrated by drawings of the necessary implements (Fig. 7).²⁶

The ingredients required for the production of the lake pigments described in the Pekstok manuscript include brazilwood, slaked lime (calcium hydroxide), alum and chalk for the red lakes and buckthorn berries (crushed), clean yellow wood (probably fustic), weld, chalk and alum for the yellow lakes. The slaked lime was added after the brazilwood chips to ‘extract the colour faster and nicer’,²⁷ so in this respect these recipes are similar to the earlier ‘alkali first’ recipes. The amount of alum and chalk added is about equal in most of the recipes for red, while far more chalk than alum is generally added when making a yellow pigment. Despite their poor lightfastness, brazilwood lakes were widely used, perhaps for large-scale or ephemeral decorative projects in particular or for cheaper artefacts. Pekstok’s pigment may have been intended for such purposes: brazilwood lakes were cheaper than other red lake pigments, although even the roset type of pigment was available in different

grades. With regard to the pigments used by easel painters, Willem Beurs, writing in 1692, describes three red lake pigments: Florentine lake, made using cochineal, Haarlem lake (similar, but of less good quality) and *kogellak* (drop or ball lake), produced from brazilwood with chalk.²⁸ It is possible that Rembrandt’s pigment was of this last type.

Deterioration of brazilwood lake

It has long been known that brazilwood-derived dyes and pigments are particularly light sensitive²⁹ and that brazilwood-derived lakes deteriorate faster than those made from other natural dye sources.³⁰ However, until recently scant consideration had been given to the way in which the brazilwood-derived lake pigments were prepared and how this might affect their permanence. The historical recipes for the preparation of brazilwood lakes fall into two broad categories, as described above: the ‘alkali first’ methods, such as those described in the Pekstok papers, were more common and apparently enjoyed greater popularity up to the period in which Rembrandt was working, probably due to the fact that a more purple-hued lake was produced.

The alternative ‘acid or alum first’ methods, which produced lakes that were bright red in tone and particularly useful for producing inks, were somewhat less common at this time.³¹ Surprisingly, recent observations made at the NG suggest that the more usual ‘alkali first’ lakes may be particularly prone to degradation. For example, brazilwood lake reference samples prepared using different recipes and stored in the dark³² appear to deteriorate at different rates depending on the type of recipe followed in their preparation. Specifically, lakes made from an alkaline solution became yellowish-brown more quickly than those made using the ‘acid first’ methods (Fig. 8), although pigments produced using both methods all deteriorated eventually to a dull yellowish-brown colour.

It is not yet clear exactly why brazilwood-derived lakes made using one method would deteriorate more quickly than those produced using another, but this offers a possible explanation as to why these lakes might still deteriorate in lower paint layers, despite being protected from light. Furthermore, it is hoped that the recent identification of the marker component as urolithin C may facilitate a better understanding of the deterioration process of brazilwood-derived lakes. While this component is also present in historical textile samples dyed using brazilwoods and sappanwood,³³ it does appear to be associated only with these species and is not found in dyes obtained from other woods, such as the yellows derived from young and old fustics. The molecule seems to be relatively stable and now that its precise chemical identity is known, it may be possible to devise alternative detection strategies for the presence of these lakes in cross-sections, allowing for their confirmation without needing an unmounted sample for analysis by HPLC and enabling yellow lakes to be easily distinguished from the similarly coloured brazilwood-derived lakes following their deterioration.

Conclusions

The evidence of recipes such as that given in the Pekstok workshop manual and contemporary descriptions of available pigments suggest that brazilwood lakes could have been more widely used by

seventeenth-century Dutch painters than analytical results presently available suggest. The lightfastness of the brazilwood dye was known to be poor, but these were bright, versatile and relatively inexpensive red pigments. Deteriorated brazilwood lakes are not always easy to detect, particularly when present in complex mixtures of pigments such as those found in Rembrandt’s paint. The difficulty is compounded by the fact that the yellowish-brown colour of deteriorated brazilwood lakes is easily mistaken for a yellow lake, particularly when observed under the microscope in a complex mixture of pigment particles. It is interesting that in the *Portrait of Frederick Rihel on Horseback* the brazilwood lake was not found in the surface paint, but in a lower paint layer where light would not be expected to cause a change in colour. In this case, the method of manufacturing the lake pigment may well have been a factor contributing to the deterioration, together with conditions of relative alkalinity or acidity within the paint layer to which chemical changes in other pigments, notably smalt, may have contributed.

Acknowledgements

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Notes and references

1. Bomford, D., Kirby, J., Roy, A., Rüger, A. and White, R. (2006), *Art in the Making: Rembrandt*, 2nd edn, London, National Gallery Company: 41–4.
2. Kirby, J., Spring, M. and Higgitt, C. (2005), ‘The

- technology of red lake pigment manufacture: study of the dyestuff substrate', *National Gallery Technical Bulletin* 26: 71–87.
3. Peggie, D.A., Kirby, J., Poulin, J., Genuit, W., Romanuka, J., Wills, D.F., De Simone, A. and Hulme, A.N. (2018), 'Historical mystery solved: a multi-analytical approach to the identification of a key marker for the historical use of brazilwood (*Caesalpinia* spp.) in paintings and textiles', *Analytical Methods* 10: 617–23. Available at: <https://doi.org/10.1039/C7AY02626A> (accessed 21 October 2019).
 4. Bomford *et al.* 2006 (cited in note 1) 41–4.
 5. *Ibid.*: see the individual catalogue entries for the palettes of the paintings described.
 6. *Art in the Making: Rembrandt* exhibition, National Gallery, London, October 1988–January 1989.
 7. Bomford *et al.* 2006 (cited in note 1) 96–7.
 8. *Ibid.*, p. 153 and fig. 155.
 9. *Ibid.*, pp. 170–71, 177.
 10. Robinet, L., Spring, M., Pagès-Camagna, S., Vantelon, D. and Trcera, N. (2011), 'Investigation of the discoloration of smalt pigment in historic paintings by micro-X-ray absorption spectroscopy at the Co K-edge', *Analytical Chemistry* 83: 5145–52; Spring, M., Higgitt, C. and Saunders, D. (2005) 'Investigation of pigment-medium interaction processes in oil paint containing degraded smalt', *National Gallery Technical Bulletin* 26: 56–70.
 11. Bomford *et al.* 2006 (cited in note 1) p. 177, figs 193 and 194.
 12. *Ibid.*, p. 194, figs 216 and 217.
 13. *Ibid.*, p. 189.
 14. See the paper by Larry Keith in this volume.
 15. Wieseman, M. (2010), 'Rembrandt's portrait(s) of Frederik Rihel', *National Gallery Technical Bulletin* 31: 96–111.
 16. For the taxonomy of the soluble redwoods see Gagnon, E., Bruneau, A., Hughes, C.E., Paganucci de Queiroz, L. and Lewis, G.P. (2016), 'A new generic system for the pantropical *Caesalpinia* group (Leguminosae)', *Phytokeys* 71: 1–160, doi: 10.3897/phytokeys.71.9203.
 17. Cardon, D. (2007), *Natural Dyes: Sources, Tradition, Technology and Science*, London, Archetype Publications: 274–89.
 18. Thanh, M., Nguyen, T., Awale, S., Tezuka, Y., Le Tran, Q. and Kadota, S. (2005), 'Xanthine oxidase inhibitors from the heartwood of Vietnamese *Caesalpinia sappan*', *Chemical and Pharmaceutical Bulletin* 53(8): 984–8.
 19. See Posthumus, N.W. (1943) 'Nederlandsche Pijsgeschiedenis, vol. 1' (Leiden, Brill, 1943) in *The Medieval and Early Modern Data Bank*, ed. R.M. Bell and M.C. Howell, October 19, 1998, <http://www.scc.rutgers.edu/memdb> (accessed 24 October 2021). The earliest prices given for sappanwood date from 1640. Taking the years 1649–54 as an example, the price of brazilwood – specifically Pernambuco wood – varied between 27.5 and 33.5 guilders for 100 pounds (1 *centenaar*) while sappanwood was considerably cheaper, costing between 18 and 23 guilders for the same amount. The price difference may in part reflect the growing economic activities and success of the Dutch East India Company (VOC) as the century progressed. For comparison, the price of cochineal (a Spanish monopoly and imported from Mexico by the Spanish) varied between 13.2 and 16.5 guilders a pound, some 50 to 100 times more expensive.
 20. Hermens, E. and Wallert, A. (1998), 'The Pekstok papers, lake pigments, prisons and paint-mills', in *Looking Through Paintings: The Study of Painting Techniques and Materials in Support of Art Historical Research*, ed. E. Hermens, A. Ouwkerk and N. Costaras, London, Archetype Publications: 269–94.
 21. Vandamme, E. (1974) 'Een 16e-eeuws Zuidnederlands receptenboek', *Jaarboek van het Koninklijk Museum voor Schone Kunsten Antwerpen* 1974: 101–37; see 117–18.
 22. Battus, C. [Carel Baten] (1694) *Het Secreet-boek vol heerlijke konsten...*, Leeuwarden, [printed by] Hendrik Rintjes: 296–301, 314–15, 537–41.
 23. Bomford *et al.* 2006 (cited in note 1) 229–30.
 24. Kirby, J., Spring, M. and Higgitt, C. (2007), 'The technology of eighteenth- and nineteenth-century red lake pigments', *National Gallery Technical Bulletin* 28: 69–95. By the mid-eighteenth century, the addition of alum to the aqueous extract of brazilwood dye before the alkali was the common method used as described in Dossie, R. (1758), *The Handmaid to the Arts* (2 vols), vol. 1, London [printed for] J. Nourse. For Dossie, the desired colour for a brazilwood lake was scarlet: 'if any appearance of purple be seen, add a fresh quantity of the solution of alum by degrees until a scarlet hue be produced' (pp. 60–62 and 64–6).
 25. Amsterdam City Archives, De Pekstok-notities, entry no. 15030 inv.nr. 77900 (ZKW 4D 6), 1691.
 26. Schendel, A.F.E. van (1972), 'Manufacture of vermilion in 17th-century Amsterdam: the Pekstok papers', *Studies in Conservation* 17: 70–82; Hermens and Wallert 1998 (cited in note 20).
 27. Hermens and Wallert 1998 (cited in note 20) 271.
 28. Beurs, W. (1692), *De groote waereld in't kleen geschildert ...*, Amsterdam, Johannes and Gillis Janssonius van Waesberge: 6.
 29. Cardon 2007 (cited in note 17) 283.
 30. Saunders, D. and Kirby, J. (1994), 'Light-induced colour changes in red and yellow lake pigments', *National Gallery Technical Bulletin* 15: 79–97; Kirby, J., Saunders, D. and Spring, M. (2006), 'Proscribed pigments in Northern European Renaissance paintings and the case of Paris red', in *The Object in Context:*

Crossing Conservation Boundaries. Contributions to the Munich Congress 28 August–1 September 2006, ed. D. Saunders, J.H. Townsend and S. Woodcock, London, IIC: 236–43 (i.e. *Studies in Conservation* 51, supp. 2, pp. 236–43).

31. Battus 1694 (cited in note 22) gives several: vinegar, alum chalk (pp. 299–3-1, 315–15) derived from Boltz; another for Paris red, water, alum, old urine, ground eggshells (p. 537).
32. See reference lakes described in Kirby *et al.* 2006 (cited in note 30) 236–43. Other reference lakes were prepared following recipes such as those given by Battus 1694 (cited in note 22) and similar sources as part of the research carried out for the work published in Peggie *et al.* 2018 (cited in note 3).
33. Peggie, D. (2006), *The Development and Application*

of Analytical Methods for the Identification of Dyes on Historical Textiles, PhD thesis, University of Edinburgh: 232–39.

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Rembrandt and the Rembrandtesque: the experience of artistic process and its imitation

Melanie Gifford

ABSTRACT This paper explores Rembrandt's technique of scratching into wet paint, contrasting its function in his own creative process with its role as a recognizably Rembrandtesque artistic convention. For Rembrandt, scratching into wet paint was more than a way to vary the texture of his surfaces; his practice of boldly scratching into the painted sketch to elaborate and clarify his composition was fundamental to his design process. To make these distinctly graphic marks in wet paint, he seems to have used a graphic tool, the reed pen he used in a similar way in many drawings to refine and focus the composition. Within Rembrandt's circle, however, there seems to have been a general consensus that simply scratching into wet paint evoked his style. This study follows the evolving role of the scratching technique from novel innovation to artistic convention, drawing on cognitive science to propose an analogy with the evolution of language laid out in the 'career of metaphor' theory. Considering works by artists who exaggerated Rembrandt's technique in the context of the 'peak shift effect' offers more evidence that his contemporaries viewed scratching as a salient feature of his style. By comparison with often perfunctory Rembrandtesque imitations, the work of Rembrandt's last student, Aert de Gelder, demonstrates a more nuanced understanding of his artistic goals. Although De Gelder worked on an exaggerated scale, scratching into wet paint with outsized tools, his varied handling evoked the full range of Rembrandt's graphic vocabulary in paint.

Introduction

Seventeenth-century painters' thoughts on the handling and artistic style of their contemporaries can seem elusive to the modern observer. Although valuable evidence can be found in writings on art from that period, authors who wrote on art represent just a small subset of all practising artists. However, the paintings themselves offer essential evidence of the artistic thinking involved. This paper considers ways in which painters responded to their fellow artists' style, in particular to such a dominant force as Rembrandt van Rijn.¹ Rembrandt's painting practices were integral to the visual qualities of

his finished works – his paintings were known for rough surfaces and an unfinished appearance, often revealing stages of the painting process that his contemporaries concealed in their finished works.² The specific features that artists in Rembrandt's circle chose to appropriate offer telling evidence of how seventeenth-century viewers characterised his style. The present contribution focuses on one distinctive technique: Rembrandt's habit of scratching into wet paint and on responses to this practice within his circle. This discussion offers empirical interpretation of painting practices, while also drawing briefly on neuroscience research for evidence of cognitive processes that could give rise to these techniques.



Figure 1 Rembrandt, *Self-Portrait at the Age of 63*, 1669, oil on canvas, 86 × 70.5 cm, bought, 1851, The National Gallery, London: detail. Photo © The National Gallery, London.

Scratching technique in Rembrandt's personal painting practice

It is often presumed that successful imitation of the visual effects that characterise an artist's style must depend on replicating the original techniques. This has been suggested in the case of Rembrandt, a teacher whose students' paintings were on occasion sold as his work. Arnold Houbraken reported that Govaert Flinck, for example, learned from his teacher so well that his brushwork was sometimes taken for Rembrandt's.³ However, technical study shows that similarities of style do not always depend on replicating the original technique.

Paintings evoking Rembrandt's manner offer evidence of a consensus among his contemporaries that some type of scratching into wet paint was considered a prominent feature of his style. Rembrandt himself seems to have worked this way in two different circumstances. In the first, illustrated in the late *Self-Portrait at the Age of 63* of 1669 (London, National Gallery), he made scratches into the surface of the final paint (Fig. 1). Rembrandt's extraordinary manipulation of surface textures served as an emphatic focal device. He directed the viewer's attention to his worn face with vigorously worked

paint, including scratches into the eyebrows and on the tip of the nose. Here, scratching serves as part of Rembrandt's broader textural vocabulary along with his well-known impastoed brushwork and palette knife application. The second way in which Rembrandt used scratching is a more fundamental aspect of his practice; here the artist scratched into wet paint at the earliest stages of the painting process as he developed his composition. These marks were an essential part of Rembrandt's painted sketch and can often be seen where he left the sketch visible. In the *Landscape with a Castle c.1640–42* (Paris, Musée du Louvre), he first brushed out his sketch and then cut into the brown and black paint, scratching finer lines in the distance and building up to broad, eccentric lines in the foreground (Fig. 2a).

Close examination of examples of Rembrandt's scratching, both into the painted sketch and the final paint, reveals that he employed not the end of a brush handle, as is often suggested,⁴ but a squared-off tool. Occasionally this tool seems to have divided, creating pairs of parallel lines separated by a ridge of paint: for example, in the tip of the nose in the *Self-Portrait* of 1669 (see Fig. 1). The tool that this brings to mind – with its split, rectangular tip – is a reed pen, which Rembrandt used frequently in drawings.



Figure 2 (a) Rembrandt, *Landscape with a Castle*, c.1640–42, oil on panel, 44.3 × 60 cm, Musée du Louvre, Paris: detail showing scratching into the painted sketch. Photo: Mathieu Rabeau © RMN-Grand Palais/Art Resource, NY. (b) Constantijn van Renesse (revised by Rembrandt), *The Annunciation*, c.1652, pen and brown ink, red chalk, wash, white heightening, 17.4 × 23.1 cm, Kupferstichkabinett, Staatliche Museen zu Berlin: detail of reed pen corrections. Photo: bpk Bildagentur/Staatliche Museen zu Berlin/Art Resource, NY.

In his painting process Rembrandt often used scratching to elaborate and clarify the painted sketch. It is intriguing that when working on paper he drew with a reed pen in the same way. In the final stages of many of his drawings he used it to refine and focus the composition with bold strokes. Rembrandt's students certainly had personal experience of his reed pen used as a bold corrective in drawings. For example, a well-known drawing of *The Annunciation* 1652 (Berlin Kupferstichkabinett, Staatliche Museen zu Berlin) by one of his students, probably Constantijn van Renesse (Fig. 2b), shows the teacher's decisive revisions in heavy pen work; after Rembrandt's intervention a new angel towered over the young artist's diffident messenger.⁵ A close look at this handling, analogous to the scratched-in description of the tree in the Paris landscape painting, reveals that the reed pen usually created solid unbroken lines. On occasion, however, when pressed hard, the nib split apart. In areas such as the heavy line to the left of the Virgin's face it created parallel lines like those seen in some of Rembrandt's scratches into paint.

When Rembrandt took up the reed pen while painting, he seems to have treated it specifically as a drawing tool. It is unlikely that its use for this unusually graphic part of the painting process was

accidental – that he simply reached for the closest available tool. Instead, a concept taken from cognitive science, 'procedural memory,' is relevant in this case.⁶ Tasks that have been so well mastered that they do not require conscious attention are often entwined with the objects used for the task (e.g. it is easier to demonstrate how to tie a shoe with a shoelace than to describe the process verbally). Because Rembrandt was effectively drawing rather than painting when he scratched into wet paint, a reed pen would have been more appropriate than the handle of his paintbrush, although that tool was already in use. The feel of the reed pen in the hand would have been entwined with the implicit (or unconscious) memory of the drawing gestures made with it: bold, angular strokes that sometimes split open the point of the pen.

Although scoring wet paint is not unique to Rembrandt and his circle, it was not widespread in the early seventeenth century. This practice typically was used to create mimetic effects in localised areas: some artists seemed to draw on an established decorative tradition of wiping and scratching painted surfaces to mimic materials such as stone; others used scratching as a routine shortcut for repetitive depictions such as fish nets; and some incised fine lines to create effects that even the smallest brush could not achieve.⁷

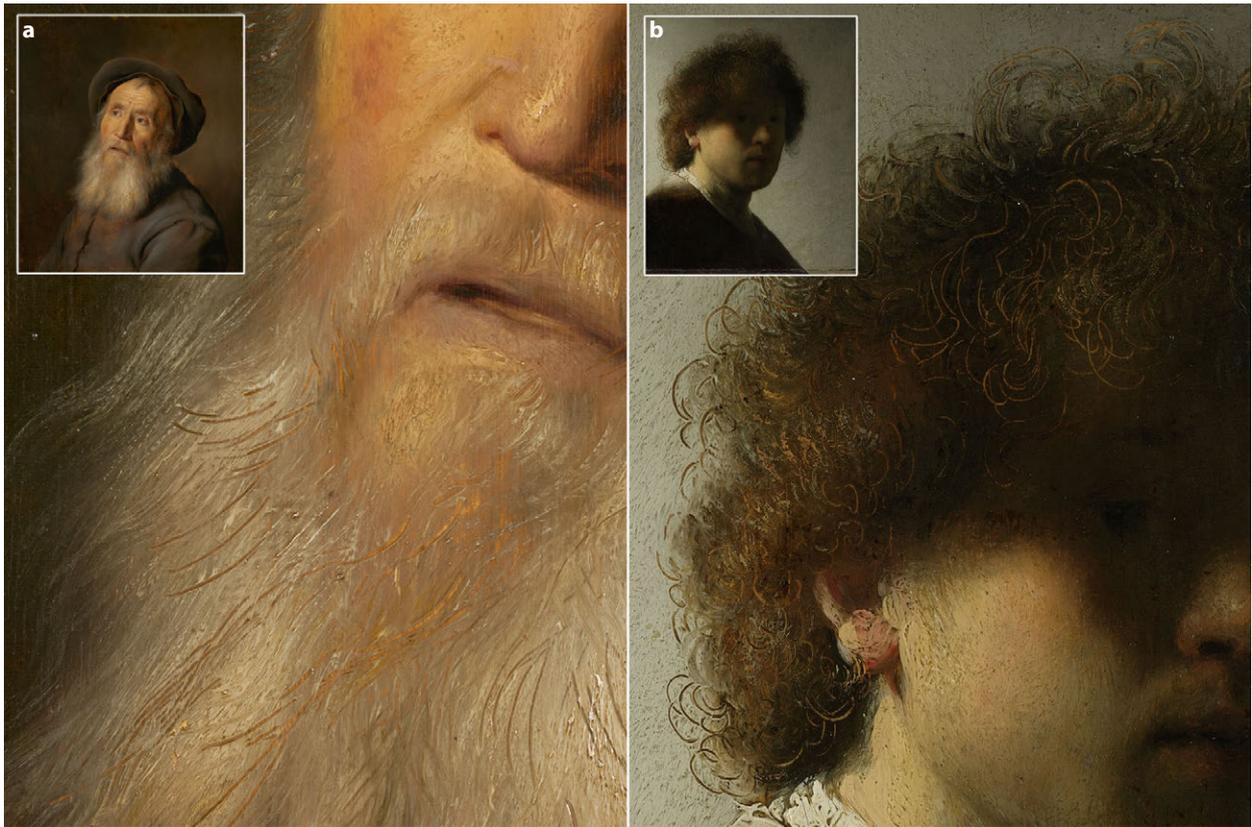


Figure 3 (a) Jan Lievens, *Bearded Man with a Beret*, c.1630, oil on panel, 53.5 × 46.3 cm: detail showing scratching into wet paint of the beard. Photo courtesy of National Gallery of Art, Washington, DC: (b) Rembrandt, *Self-Portrait*, c.1628, oil on panel, 23.4 × 19.5 cm: detail showing scratching in the hair. Photo courtesy Rijksmuseum, Amsterdam.

The cognitive context of a Rembrandtesque style signifier

At the start of their careers in the late 1620s, Rembrandt and Jan Lievens, his friend and rival in Leiden, both scratched into wet paint – not for localised effects but as an integral part of their painting technique. Both artists quickly became fluent in this technique, exploiting its expressive possibilities to describe a range of details and to vary the surface of their works. In the *Bearded Man with a Beret* painted around 1630 (Amsterdam, Rijksmuseum), Lievens made long wavy scratches to evoke a soft and silky beard (Fig. 3a), while in his self-portrait of 1628, Rembrandt's more abrupt scratches captured the wiry quality of his own curls (Fig. 3b). Both artists varied their touch, digging below the dark paint to expose light coloured lines and gently revealing dark undertones to create hairs against a light background. They also used wispy touches of dry brushwork to depict a wider range of hair textures and light effects.

Within Rembrandt's circle the reaction to this technique ranged from inept imitation to sympathetic responses attuned to the nuances of Rembrandt's expression. Rembrandt took on students from the earliest years of his career, and the impact of his work can also be seen in paintings by a wider range of artists.⁸ Ernst van de Wetering has identified a small group of paintings that he suggests were produced in Rembrandt's orbit during his early career in Leiden. Naming the artist the 'Master of the Lofty Room' after a work now in London, Van de Wetering linked these paintings based on their shared dependence on scratching into wet paint.⁹ In these works, which are among the less subtle imitations of Rembrandt's manner, it is striking how little the painter exploited the expressive possibilities of this technique. In *A Man Seated Reading at a Table in a Lofty Room* c.1628–30 (London, National Gallery), both the hinges of the window and the cracks creeping across the wall were described with unvaried furrows scored deeply into thick paint (Fig. 4a). By comparison, the example set around this time

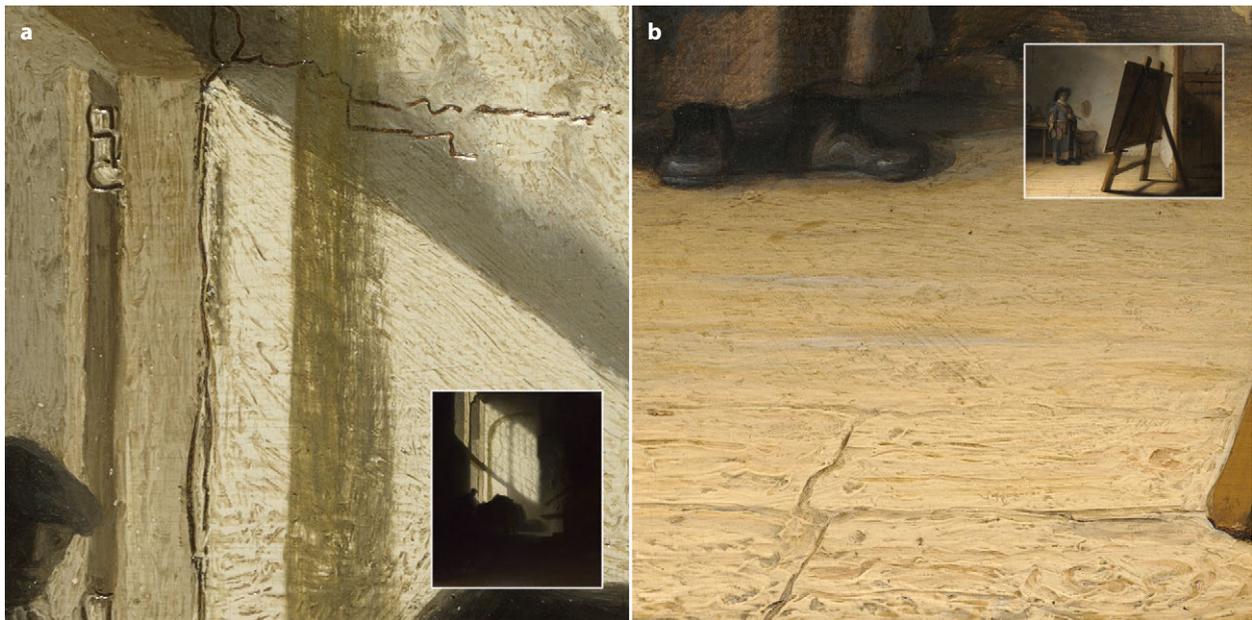


Figure 4 (a) Circle of Rembrandt, *A Man Seated Reading at a Table in a Lofty Room*, c.1628–30, oil on panel, 55.1 × 46.5 cm, bought 1917: detail showing deep, repetitive scratches into wet paint. Photo © The National Gallery, London. (b) Rembrandt, *Artist in his Studio*, c.1628, oil on panel, 24.8 × 31.7cm, Bredius 419; RRP A 18. Museum of Fine Arts, Boston, Zoe Oliver Sherman Collection given in memory of Lillie Oliver Poor (38.1838): detail showing varied manipulation of paint. Photo © Museum of Fine Arts, Boston.

by the young Rembrandt in *Artist in his Studio* c.1628 (Boston, Museum of Fine Arts), extends far beyond repetitive scratching (Fig. 4b). Rembrandt rendered wandering cracks in the shadowed wall with strokes of paint, while in the brightly lit planks of the foreground floor he used a tool to push into and out of the wet paint, effectively sculpting an evocation of the wood's rough texture.

We might reasonably wonder whether the 'Master of the Lofty Room' was too inept to achieve, or perhaps did not notice, such a range of effects. However, it could be that the goal was simply to mimic a general impression of vigorous paintwork of which scratching was an essential component. A more precise imitation of Rembrandt's varied touch would not only have been challenging to execute but may also have seemed unnecessary if just a superficial similarity served to render a painting Rembrandtesque.

A particular use of scratching – a mimetic handling to describe hair and beards – was widespread among artists whose works exhibit an awareness of Rembrandt's style.¹⁰ Werner Sumowski's volumes on these painters record frequent examples in the 1630s and 40s, most commonly in the depictions of old men often found in the informal character studies known as 'tronies'.¹¹ Such consistency suggests that this application of the scratching technique evolved

during these years from a personal characteristic into a more widely recognised artistic convention. This progression bears a similarity to the evolution of language laid out in another concept from cognitive science: 'career of metaphor'.¹² Research has documented how a novel verbal metaphor will evolve, with frequent repetition, from a concept requiring considerable neural processing into an idiomatic expression. The brain activity associated with conventional idioms suggests that they are processed more like ordinary language than novel metaphors.¹³ It seems possible that this represents an artistic characteristic following a similar evolution: with frequent repetition, a painting technique that was eye-catching when it first appeared developed into a predictable convention.¹⁴

The frequency of scratching into wet paint among those artists working in Rembrandt's environment suggests that over time this technique came to function as a conventionalised reference to Rembrandt's style. Correspondingly, this convention disappeared from most artists' work by mid-century, as the dominant artistic taste turned toward a more elegant finish, with more smoothly handled paint. Even Lievens – although both he and Rembrandt had cultivated this technique in their formative years – abandoned it as he moved towards a courtly

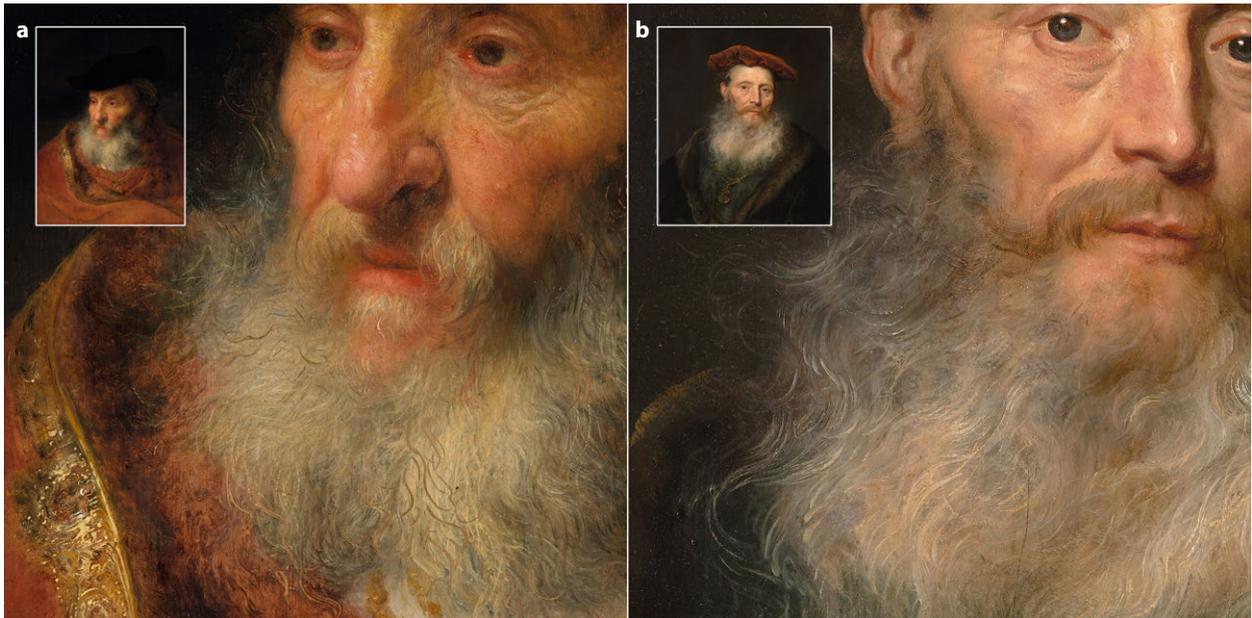


Figure 5 (a) Govaert Flinck, *Head of an Old Man*, c.1642, oil on panel, 64 × 47 cm: detail showing scratched paint in the beard. Photo © National Gallery of Ireland, Dublin. (b) Govaert Flinck, *Bearded Man with a Velvet Cap*, 1645, oil on panel, 60.3 × 52.4 cm: detail showing scratched paint in the beard. Photo courtesy of The Metropolitan Museum of Art, New York.

manner in the 1640s. Two tronies by Flinck illustrate the rapidity of this transition in the work of one artist. Each painting portrays a white-bearded man with rich fur-lined garments, a gold medal and beret. Around 1642, in *Head of an Old Man* (Dublin, National Gallery of Ireland), Flinck painted a wrinkled face with discrete touches of pasty paint that echoed Rembrandt's rough finish, evoking tendrils of the beard with scratched-in curls (Fig. 5a). In 1645, barely three years later, Flinck evinced a more elegant Flemish style in *Bearded Man with a Velvet Cap* (New York, The Metropolitan Museum of Art): he blended creamy pink tones to depict the face and in the silky cloud of the beard he replaced the Rembrandtesque scratching with fine, sinuous strokes of grey and white paint (Fig. 5b).

Although by the middle of the century many artists who had earlier embraced a Rembrandtesque style rejected scratching, Rembrandt made the technique an integral part of the forceful handling for which his late work is known; those artists who did respond to this late manner used the convention of scratched depictions of hair with particular emphasis. In *Christ with a Staff* (New York, The Metropolitan Museum of Art), painted by a follower of Rembrandt around 1661 (Fig. 6a), the artist scored the paint with large looping gestures to extend the flowing hair. When compared to Rembrandt's

depiction of hair around the same time in his *Self-Portrait* of 1659 (Washington, DC, The National Gallery of Art) (Fig. 6b), this anonymous artist's generic handling seems to overlook the sophistication with which Rembrandt interwove angular scratches and a few curls of yellow paint dragged with a dry brush. But another aspect of *Christ with a Staff* is striking: the scale of the scratching seems remarkably exaggerated.

Such exaggeration calls to mind yet another cognitive science concept: the 'peak shift effect'. If, in training, subjects are rewarded for choosing one stimulus (S^+) over an alternative (S^-), this predicts that when offered a choice between the positive stimulus (S^+) and an exaggerated version of it (S^{++}), the subjects will prefer the 'supernormal' stimulus.¹⁵ Ramachandran and Hirstein perhaps oversimplified when they suggested that an evolving tendency to exaggeration is a fundamental force of artistic evolution, with the aphorism 'all art is caricature'.¹⁶ However, this principle is useful in a more narrow context: when isolating those characteristics of an influential artist's style that stood out to their contemporaries. For the painter of *Christ with a Staff*, working closely in Rembrandt's environment, the 'reward' posited by the 'peak shift effect' must have been the achievement of a convincingly Rembrandtesque effect. The 'supernormal' scratching suggests that the artist

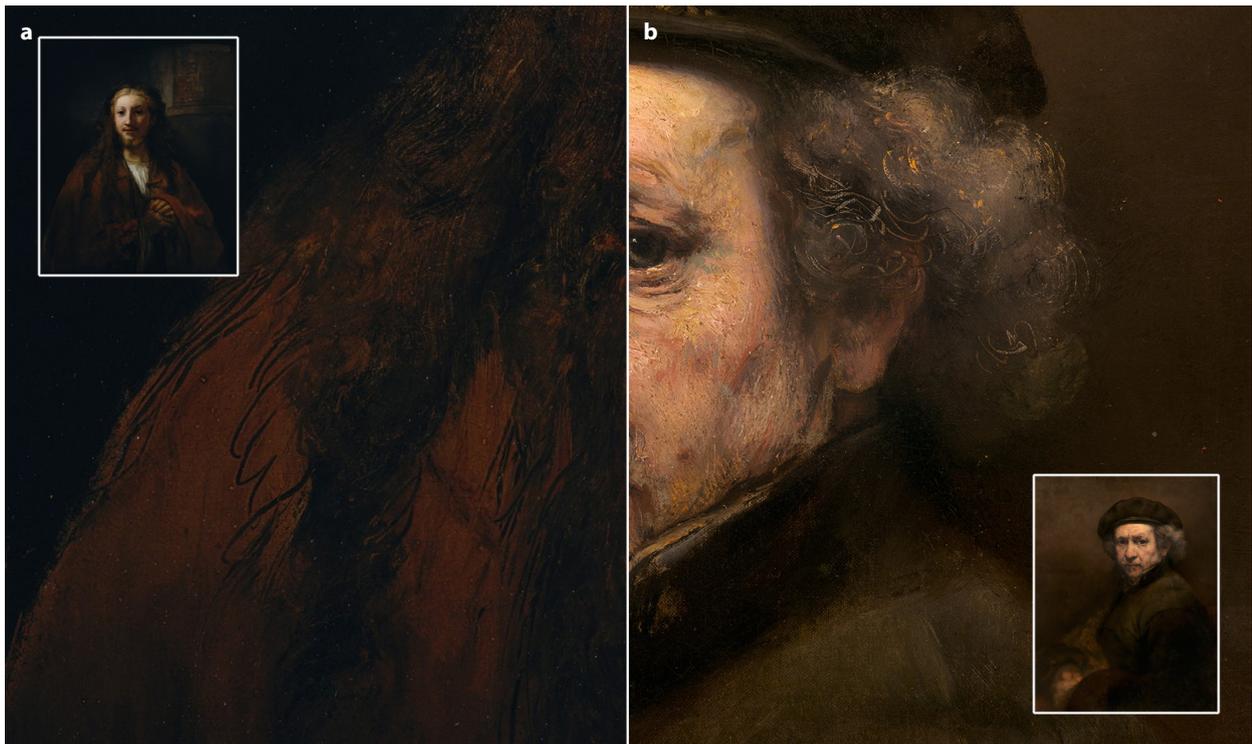


Figure 6 (a) Follower of Rembrandt, *Christ with a Staff*, c.1661, oil on canvas, 95.3 × 82.6 cm: detail showing scratched paint in the hair. Photo © The Metropolitan Museum of Art, New York. (b) Rembrandt, *Self Portrait*, 1659, oil on canvas, 84.5 × 66 cm: detail showing scratched paint in the hair. Photo courtesy of National Gallery of Art, Washington, DC.

regarded this particular style of handling as a salient feature of Rembrandt's style.

Aert de Gelder and the sympathetic response

Early in the 1660s, Rembrandt took on his last known pupil, Aert de Gelder.¹⁷ Most seventeenth-century artists gradually evolved a personal style independent of their teacher's work: like Flinck, evidence of their master's style was seen in their early works, but as they established their own place in the art market, their mature works tended to take a new direction. Although De Gelder developed his own recognisable manner, his paintings also clearly allude to Rembrandt's late style – not only in the early works soon after his training but also throughout his career, well into the eighteenth century.¹⁸ This can be seen in particular in his conspicuous use of scratching into wet paint. His consistent adherence to this technique, at a time when most of his contemporaries had adopted a smooth finish for their works, suggests that this was not simply a



Figure 7 Rembrandt, *The Concord of the State*, c.1637–45, oil on panel, 74.5 × 101 cm, inv. no. 1717 (OK) Museum Boijmans Van Beuningen, Rotterdam. Photo: Studio Tromp, Rotterdam.

residual by-product of his training, but reflected a personal preference.

De Gelder's scratching technique is striking, not only because he scratched throughout the focal areas



Figure 8 Aert de Gelder, *King Ahasuerus Presents Mordecai with his Ring*, c.1685, oil on canvas, 79 × 96.5 cm, National Museum of Denmark, Copenhagen. Photo © Jakob Skou-Hansen/ SMK.

of his composition but also because of its exaggerated scale. Like Rembrandt, he used a squared-off tool, but he chose an implement far broader than a reed pen – perhaps the end of a palette knife. In *King Ahasuerus Condemning Haman* (Melbourne, National Gallery of Victoria), painted around 1680, the squared score marks that describe a patterned fabric are as much as 4 mm wide.¹⁹ De Gelder's remarkably emphatic version of scratching into wet paint suggests that he viewed this technique as fundamental to Rembrandt's style and that he privileged it over other characteristics. De Gelder not only retained Rembrandt's scratching technique in the face of the smoothly handled Dutch classicism of the mid-seventeenth century, he also amplified it precisely as predicted by the peak shift effect, suggesting that he found this aspect of Rembrandt's manner personally rewarding. Economic constraints may have played a role in discouraging other Rembrandt students from this path: De Gelder's family was affluent and his livelihood was not dependent on the sale of his paintings.²⁰ By comparison with most of Rembrandt's students, who could not afford to reject the vogue for a smoother finish, he must have felt free to follow his artistic preferences.

In some works it is clear that De Gelder's approach to painting technique was more nuanced than that of many painters who quoted Rembrandtesque style when it was fashionable in the 1630s and 40s simply by scratching into surface paint. Although some of Rembrandt's peers and students apparently were aware that he often used a reed pen in wet paint,²¹ in most examples observed to date scratching served only to vary the texture of the final surface – few pupils seem to have recognised that for Rembrandt the most important function of the reed pen was as a graphic tool for revising and refining his compositions during the design stage. De Gelder, however, is an example of the 'sympathetic response' proposed in this paper: a Rembrandt student who, in addition to appreciating the textural variation that scratching brings to a painted surface, appears to have understood the fundamentally graphic language that his master used when scratching into wet paint.

It is striking to compare Rembrandt's graphic manipulation of paint in *The Concord of the State* of 1637–45 (Rotterdam, Museum Boijmans Van Beuningen) (Fig. 7) to De Gelder's handling in *King Ahasuerus Presents Mordecai with his Ring* (Copenhagen, National Museum of Denmark),

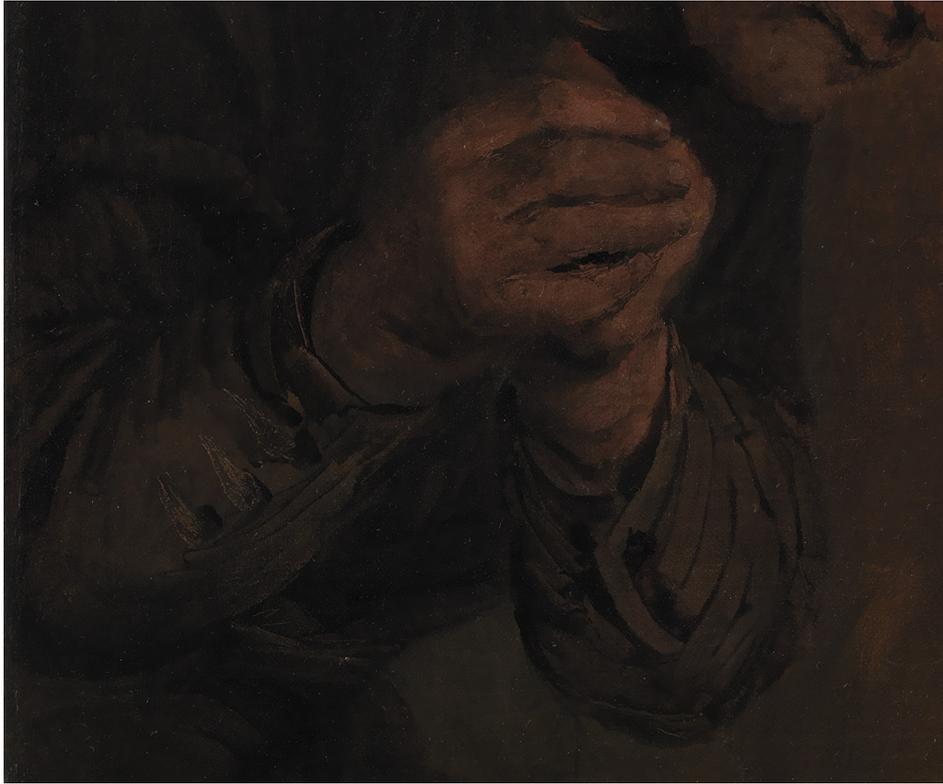


Figure 9 Aert de Gelder, *King Ahasuerus Presents Mordecai with his Ring*, c.1685: detail showing the artist's graphic handling of paint.

painted some 40 years later in 1685 (Fig. 8). In Rembrandt's work most of the painted sketch is completely exposed.²² In much the same way, De Gelder created a sketch-like effect that dominates the final image, but at every step of the process he worked on an outsize scale.

The Concord of the State is characterised by a riot of lines in the brown paint in a rich, graphic vocabulary of both brushwork and scratching. Dark brown brushed lines define the standing boy holding the horse with areas of dark wash below the saddle. Rembrandt made scratches with several tools: he used a fine point, perhaps an etching needle, to scribble away some of the dark wash, creating half-tone shadows in the horse's hindquarters and tail, and a broader, square tool, probably the reed pen again, to define forms such as the horse's hooves with bold angular strokes.²³ De Gelder depicted the kneeling Mordecai with almost monochromatic paint, representing the turban by scraping away the blackish paint with a wide, square tool. Mordecai's sleeves, however, demonstrate De Gelder's esteem not only for surface scratching but for all aspects of Rembrandt's graphic vocabulary (Fig. 9). In the

shadowed sleeve at the left, he indicated folds with lines of dark paint: just as Rembrandt had in *The Concord of the State* but on a much broader scale. In the shadowed side of the right-hand sleeve he created halftones by partially removing the paint: not with a fine tool like Rembrandt but perhaps using his finger. On the lit side of that sleeve he created highlights by scraping through the dark paint with a particularly large squared-off tool, creating lines four times as wide as Rembrandt's. The outsized scale of the varied handling in this passage suggests that for De Gelder, the salient feature of his master's technique was not scratching alone but the full range of Rembrandt's graphic expression in wet paint.

Conclusions

For Rembrandt, the boundaries between the painting process and graphic mark-making were fluid: his process seamlessly interwove graphic and painting gestures. It is possible that the alternate feel in his

hand of a graphic tool (the reed pen) and the painting tool (the paint brush) kept both graphic and painterly ways of thinking in working memory, 'at the front of his mind.' Most artists in Rembrandt's circle did not respond to these subtleties; those who typically appropriated his style immediately after their training regarded a painting surface with scratch marks as a well-known convention, which they imitated as efficiently as possible. De Gelder was the rare, perceptive painter who recognised more than the surface aspects of this technique. By sharing the full range of Rembrandt's gestures, both painterly and graphic, he must have shared something of Rembrandt's creative experience.

Acknowledgements

I am very grateful to Ashok Roy, who encouraged my exploration of these ideas with thoughtful conversations and practical support. Anjan Chatterjee and his research group at the Center for Cognitive Neuroscience (University of Pennsylvania), especially Eileen Cardillo, were very generous, offering cogent feedback on an earlier version of this paper.

Notes and references

1. Some of this discussion builds on material discussed elsewhere: see Gifford, M. (2011), 'Material as metaphor: non-conscious thinking in seventeenth-century painting practice', in *Studying Old Master Paintings: Technology and Practice*, ed. M. Spring, London, Archetype Publications: 165–72; Gifford, M. (2012), 'Material innovation and convention', paper presented at the *Copying, Replicating & Emulating Paintings in the 15th–18th Century* conference, Copenhagen, 21 May 2012. A version of this paper also appears in Koopstra, A., Seidel, C. and Waterman, J.P. (eds) (2022), *Tributes to Maryan W. Ainsworth; Collaborative Spirit: Essays on Northern European Art, 1350–1650*, Turnhout, Brepols/Harvey Miller.
2. Gerard de Lairese, a proponent of smooth handling, disparaged Rembrandt's and Lievens' rough technique with paints that 'run down the piece like dung': see De Lairese, G. (1707), *Groot Schilderboek: waar in de schilderconst in al haar deelen grondig werd orderweezen, ook door redeneeringen en prentverbeeldingen verklaard...*, Amsterdam, pt. 1: 324. Contemporaries were struck by Rembrandt justifying what seemed to be unfinished paintings: 'a work is finished when the master has achieved his intention in it': Houbraken, A. (1718–21), *De Grootte Schouburgh der Nederlantsche Konstschilders en Schilderessen...* (3 vols), vol. 1, The Hague: 259. Both translations appear in Van de Wetering, E. (2000), *Rembrandt: The Painter at Work*, rev. edn., Berkeley, University of California Press: 156, 164.
3. Van de Wetering, E. (2001), 'Delimiting Rembrandt's autograph oeuvre – an insoluble problem?' in *The Mystery of the Young Rembrandt*, ed. E. van de Wetering and B. Schnackenburg, exh. cat., Kassel, Staatliche Museen Kassel and Amsterdam, Museum het Rembrandthuis: 59; Houbraken 1718–21 (cited in note 2) vol. 2, 21.
4. Van de Wetering 2001 (cited in note 3) 79.
5. Bevers, H. (2009), 'Drawing in Rembrandt's workshop', in *Drawings by Rembrandt and his Pupils*, ed. H. Bevers, L. Hendrix, W. Robinson and P. Schatborn, Los Angeles, The J. Paul Getty Museum: 25.
6. Squire, L.R. (2004), 'Memory systems of the brain: a brief history and current perspective', *Neurobiology of Learning Memory* 82(3): 173–4.
7. Pieter Paul Rubens 'scratched' with a stiff-bristled brush to suggest a stone ledge in *Agrippina and Germanicus c.1614* (Washington, DC, The National Gallery of Art). Pieter de Putter, who specialised in paintings of fish and fishermen, used scratching to depict fishnets efficiently: see, for example, lots 4 and 5 in Christie's, Amsterdam, Sale 3050, *Old Masters, 19th Century and Impressionist Art, 25–26 November 2014* (I am grateful to Jaco Rutgers for bringing de Putter's practice to my attention). Gabriel Metsu incised fine lines with a knife to evoke the vibrating strings of the lute in *A Young Woman Composing a Piece of Music c.1664* (The Hague, Mauritshuis).
8. Van de Wetering 2001 (cited in note 3) 59–60.
9. *Ibid.*, 78–9, 312–23.
10. In her paper in this volume, Rosanna de Sancha illustrates Ferdinand Bol's use of scratching to depict wisps of hair in *Rembrandt and his Wife Saskia c.1638* (Windsor, The Royal Collection), a modest response to Rembrandt's brilliant handling.
11. See, for example, a number of works by anonymous students and imitators of Rembrandt: Sumowski, W. (1983–1991), *Gemälde der Rembrandt-Schüler in vier Bände und einem Supplement-Band*, vol. IV, Landau, Edition PVA: 2902, 2911, 2912, 2915, 2986, 2997. This technique was perhaps seen as particularly appropriate to tronies, whose characteristic informality and sketchy handling distinguished them from formal portraits: Hirschfelder, D. (2008), *Tronie und Porträt*

- in der niederländischen Malerei des 17. Jahrhunderts*, Berlin, Gebr. Mann: 100–105; Gottwald, F. (2011), 'The heads of Christ in the context of the *tronie*', in *Rembrandt and the Face of Jesus*, ed. L. Dewitt, exh. cat., Philadelphia, Philadelphia Museum of Art/ Paris, Musée du Louvre/ Detroit, Detroit Institute of Arts: 149.
12. Bowdle, B. and Gentner, D. (2005), 'The career of metaphor', *Psychological Review* 112(1): 193–216.
 13. Cardillo, E., Watson, C., Schmidt, G. *et al.* (2012), 'From novel to familiar: tuning the brain for metaphors', *NeuroImage* 59: 3213–21.
 14. On an application of the career of metaphor theory to the visual arts, see Gifford, M. (2019), 'Pieter Bruegel's afterlife: a visual metaphor in seventeenth-century landscape', *Nederlands Kunsthistorisch Jaarboek* 69: 43–72.
 15. Hanson, H. (1959), 'Effects of discrimination training on stimulus generalization', *Journal of Experimental Psychology* 58: 321–34; Martindale, C. (1999), 'Peak shift, prototypicality and aesthetic preference', *Journal of Consciousness Studies* 6(6–7): 52–4.
 16. Ramachandran, V. and Hirstein, W. (1999), 'The science of art: a neurological theory of aesthetic experience', *Journal of Consciousness Studies* 6(6–7): 15–51.
 17. Von Moltke, J. (1994), *Arent de Gelder: Dordrecht 1647–1727*, ed. K. Belken, Davaco, Doornspijk: 1–8; Dordrechts Museum (1998), *Arent de Gelder (1645–1727): Rembrandts laatste leerling*, exh. cat., Dordrecht, Dordrechts Museum/ Cologne, Wallraf-Richartz-Museum/ Ghent, Snoeck-Ducaju & Zoon.
 18. Van de Wetering, E. (1998) 'Opmerkingen over de relatie tussen techniek, stijl en toeval bij Arent de Gelder; een vergelijking met Rembrandt', in Dordrechts Museum 1998 (cited in note 17) 18–35.
 19. I am grateful to Carl Villis, conservator of paintings at the National Gallery of Victoria, Melbourne, for documentation of the scale of these marks.
 20. Pastoor, G. (1998), 'The life of Arent de Gelder', in Dordrechts Museum 1998 (cited in note 17) 2–3. Van de Wetering points out that De Gelder's estate inventory (Von Moltke 1994 [cited in note 17] 200–204) documents that about 70 of De Gelder's own works – a substantial part of his oeuvre – remained in his possession at his death: Van de Wetering 1998 (cited in note 18) 35.
 21. There is visual evidence that on occasion other artists in his circle also used this tool. Typical paired parallel lines have been observed, for example, in the scratched rendering of the beards in early works by Lievens and Flink illustrated above (see Figs 3a and 5a).
 22. The literature records varied opinions as to whether this painting is a finished work, as well as on its original function (an independent work of art or a preparatory design for either a larger painting or a print): Hermesdorf, P., Van de Wetering, E. and Giltaij, G. (1986), 'Enkele nieuwe gegevens over Rembrandts "De Eendracht van het Land"', *Oud Holland* 100(1): 35–49; Bruyn, J., Haak, B., Levie, S.H., Van Thiel, P.J.J. and Van de Wetering, E. (1989), 'A135 The Concord of the State', in *A Corpus of Rembrandt Paintings III*, Dordrecht/Boston/London, Martinus Nijhoff Publishers: 341–56. More recently Van de Wetering has argued that this is an unusually large grisaille oil sketch prepared for an outsized print made from two or more plates: Van de Wetering, E. (2000), 'Remarks on Rembrandt's oil-sketches for etchings', in *Rembrandt the Printmaker*, ed. E. Hinterding, G. Luijten and Royalton-Kisch, M, exh. cat., Amsterdam, Rijksmuseum: 56–7. Magnified examination of the painting by the author was not intended to address the question of the painting's function, but did establish that the painting technique appears consistent with the preliminary sketch and underpaint stages of Rembrandt's technique in paintings such as *Landscape with a Castle* (see Fig. 2a) and *Landscape with the Good Samaritan*, signed and dated 1638 (Kraków, Muzeum Ksiązaty Czartoryskich): Gifford, M. (2006), 'Evocation and representation: Rembrandt's landscape painting technique', in *Rembrandt's Landscapes*, ed. C. Vogelaar and G.J.M. Weber, exh. cat., Museum de Lakenhal, Gemäldegalerie Alte Meister, Leiden, Kassel: 120–43.
 23. Claudia Laurenze-Landsberg has speculated that Rembrandt used an etching needle or burin for fine-scaled marks scraped into wet paint: The Rembrandt Database, technical report, July 2012, Claudia Laurenze-Landsberg; Rembrandt, *Parable of the Rich Man*, 1627, Berlin, Gemäldegalerie (Staatliche Museen zu Berlin), inv./cat. no. 828 D, <https://rkd.nl/en/explore/technical/record?query=Parable+of+the+rich+man&start=6&tmpl=pdf&pdf=b1889640-46aa-a79e-001c-b3f32e8a1156> (accessed 30 October 2021): 7.

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A note on Samuel van Hoogstraten's *Christ and the Women of Jerusalem*: apprenticeship, practice, influence

Peter Black and Erma Hermens

ABSTRACT Scientific examination of an undated canvas in Glasgow, *Christ and the Women of Jerusalem*, by the Dutch painter Samuel van Hoogstraten (1612–1678), reveals evidence of a ‘quartz ground’, a method of canvas preparation so far only found in works made in Rembrandt’s workshop, and suggestive of a date in the late 1640s when Hoogstraten worked there. However, a late dating of 1665–1675, assigned by Werner Sumowski, has been followed by subsequent authors. In this paper, the passion subject as well as the work’s provenance, which goes back to a family of the painter’s close supporters in Dordrecht, is combined with the technical evidence to support a date during or in the years immediately after his period in Rembrandt’s workshop in the late 1640s or early 1650s.

Introduction

The painting of *Christ and the Women of Jerusalem* (Fig. 1) by Samuel van Hoogstraten (1627–1678) in the Hunterian Art Gallery, Glasgow, is one of an interesting collection of 26 Dutch and Flemish works gifted in 1963 by Ina Smillie, daughter of the Glasgow violin maker Andrew Smillie. They supplement a group of distinguished old masters bequeathed by the museum’s founder, Dr William Hunter, which includes Rembrandt’s *Sketch for the Entombment*. It is well known that Van Hoogstraten trained with Rembrandt (c.1642–46), and a small number of dated paintings and a slightly larger group of biblical drawings indicate that after leaving Rembrandt’s studio he continued to produce religious works in a Rembrandtesque manner. But Van Hoogstraten was also a poet and author of the *Inleyding tot de hooge school der schilderkonst: anders de zichtbaere werelt* (1678), which was the first art treatise in Dutch since Van Mander’s *Den Grondt* of 1604. He also occupied a post at the Mint of South Holland in

his native Dordrecht. Despite the variety of his skills and experience, the course of Van Hoogstraten’s later career tends to be obscured by knowledge of his few years of contact with Rembrandt. The paintings he produced in later life are mainly portraits but he also specialised in trompe l’oeil and perspectival paintings, including three-dimensional perspective ‘peepshows’, the inspiration for which he very likely found in Rembrandt’s workshop in the mid-1640s, and an expertise that he first exploited on his visit to Vienna in 1651.¹

A technical examination of the Hunterian painting, in the wake of the 2012 *Rembrandt and the Passion* exhibition, furnished the material for this paper, presented at the *Rembrandt Now* conference at the National Gallery, London, and prompted a reassessment of its dating. Analysis of paint samples (details of which are given below) has cast some doubt on the stylistic dating of the painting to the artist’s final years c.1665–75, which was established by Werner Sumowski in 1983.² As will be explained, the technical analysis seems to indicate that *Christ*



Figure 1 Samuel van Hoogstraten, *Christ and the Women of Jerusalem*, 1650–78, oil on canvas, 81.3 × 64.7 cm, Hunterian Art Gallery, Glasgow.



Figure 2 Samuel van Hoogstraten, *Christ and the Women of Jerusalem*: detail. The tone of the ground is used effectively in the drapery of the woman in the foreground.

and the Women of Jerusalem may in fact be an early rather than late painting, and would therefore fit into the group of biblical works produced in the late 1640s and early 1650s while Van Hoogstraten was still trying to live up to the experience of working with Rembrandt. The suggestion of an earlier date will be placed here into the context of Van Hoogstraten's views on apprenticeship and learning as described in his treatise, his relationship with his master Rembrandt and contemporary practice.³

Technical analysis: grounds for a change in date

Christ and the Women of Jerusalem is painted on canvas of a medium fine weave and the paint layers are generally in good condition. Examination revealed that the painting has a warm orangey-brown ground layer which in places has been left exposed; it is used, for example, to great effect in the silk garments of the woman in the left foreground (Fig. 2) and as the

light tone in the background figures on the right (Fig. 3). Samples were taken from four areas and the cross-sections indicate a preparation of the canvas with animal skin glue and a double ground, that is, the locally visible orangey-brown second layer and a darker reddish-brown first layer.⁴ There are distinct differences between the two ground layers: the upper layer contains earth pigments, chalk and lead white that render it lighter and warmer in tone compared to the darker, reddish-brown hue of the first ground layer. In the lower layer, chalk is only present as a minor component and lead white is absent altogether.

A double ground layer is quite common in seventeenth-century Dutch painting, and usually consists of a combination of a first layer containing a high proportion of earth pigments, followed by a lighter toned layer with lead white, some black and earth pigments to create a greyish tone. Such combinations of grey over red grounds have been found, for example, in works by Rembrandt and his contemporaries,⁵ and are described in many recipes in the *De Mayerne Manuscript* (1620). De Mayerne, for example, advises the reader, after the application of

an animal skin glue, to 'prime rather lightly with a brown, or red-brown from England. Let it dry and make it smooth with pumice stone. Then prime with a second and last layer of lead white, well-chosen charcoal. Small coals and a little umber to make it dry faster.'⁶ This combination of grounds was used well into the eighteenth century. In the Hunterian's Hoogstraten, however, polarised light microscopy (PLM) and scanning electron microscopy-energy dispersive X-ray (SEM-EDX) analyses indicate that the double ground did not follow this system. Rather, the first layer may correspond with Rembrandt's so-called quartz or clay grounds, as identified by Karin Groen in Rembrandt's works from 1640 until the late 1660s.⁷ From 159 paintings by Rembrandt and his close circle that were examined, 48 had a high quartz content in contrast with the results from 60 works by seventeenth-century Dutch painters not connected to Rembrandt and his studio, which did not have any quartz content in their grounds.⁸ The key characteristic of such quartz or clay grounds is the content of clay minerals with the addition of sand (quartz) and sometimes chalk.

Based on the large amount of data available on Rembrandt's grounds, Groen demonstrated convincingly that the application of such grounds in Northern Netherlandish painting is so far known only in the work of Rembrandt and his studio.⁹

References to the use of clay for preparing canvases seem to appear first in technical treatises from the second half of the seventeenth century, although Giorgio Vasari (1511–1574) had earlier described the use of potter's clay for the preparation of canvases in his *Lives of the Most Eminent Painters, Sculptors, and Architects* (editions of 1550 and 1568).¹⁰ The Spanish painter and writer Francisco Pacheco (1564–1644) mentions a ground made with clay in his *Arte de la pintura* of 1649, and notes how it was used on canvases starting in 1600, although it is not clear exactly what kind of material he is describing.¹¹ Recent research on Dutch wall hangings reveals that potter's clay was used increasingly in the late seventeenth and eighteenth century.¹² Groen points to the treatise compiled by the historian and painter Simon van Eikelenberg (1679–1704), who mentions 'potter's earth' used in the preparation of both wooden panels and canvases, emphasising its durability due to its 'tough and heavy particles'.¹³ Groen also argues that Rembrandt might have been influenced in using



Figure 3 Samuel van Hoogstraten, *Christ and the Women of Jerusalem*: detail showing the warm colour of the ground used in the background figures.

clay through his membership of the Guild of St Luke which included potters among its members.¹⁴ As Van Hoogstraten entered Rembrandt's studio in the early 1640s, he must have become aware of this practice during his apprentice years.

Analyses

SEM-EDX was used to examine the composition of the ground layers in a cross-section taken from the sky (Fig. 4). The overall EDX spectrum of the first (lower) ground layer shows a high proportion of silicon, aluminium and iron, a small amount of potassium, as well as minor quantities of titanium, magnesium and sodium, with very little calcium. The presence of aluminosilicate minerals, such as kaolinite (Si, Al, O) and illite (Al, Si, Fe, K, Mg, O),

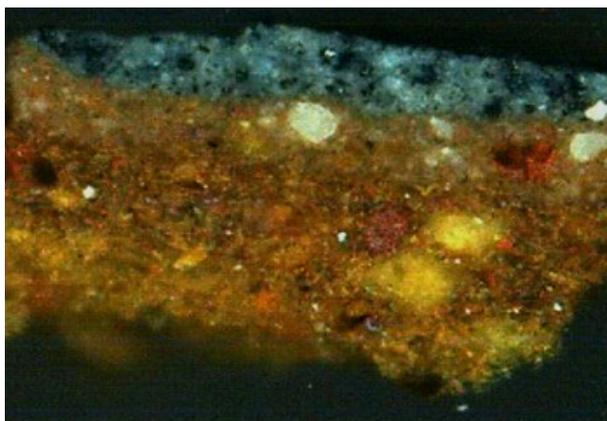


Figure 4 Samuel van Hoogstraten, *Christ and the Women of Jerusalem*: cross-section taken from the bluish sky in the centre along the top edge showing the double ground and the blue layer of the sky.

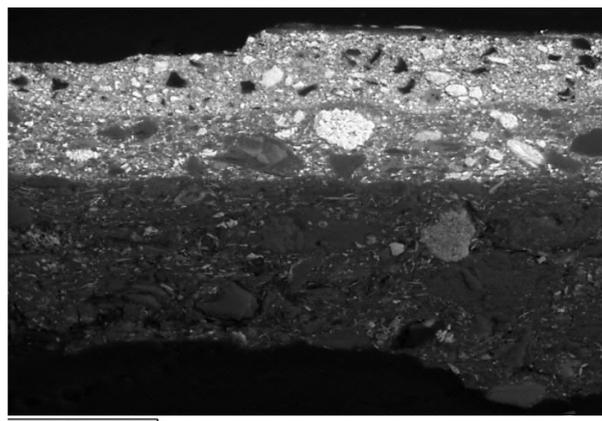


Figure 5 Backscattered SEM image of Figure 4 showing the structure of the layers. There is a clear distinction between the two ground layers. The second ground layer contains more lead white and chalk.

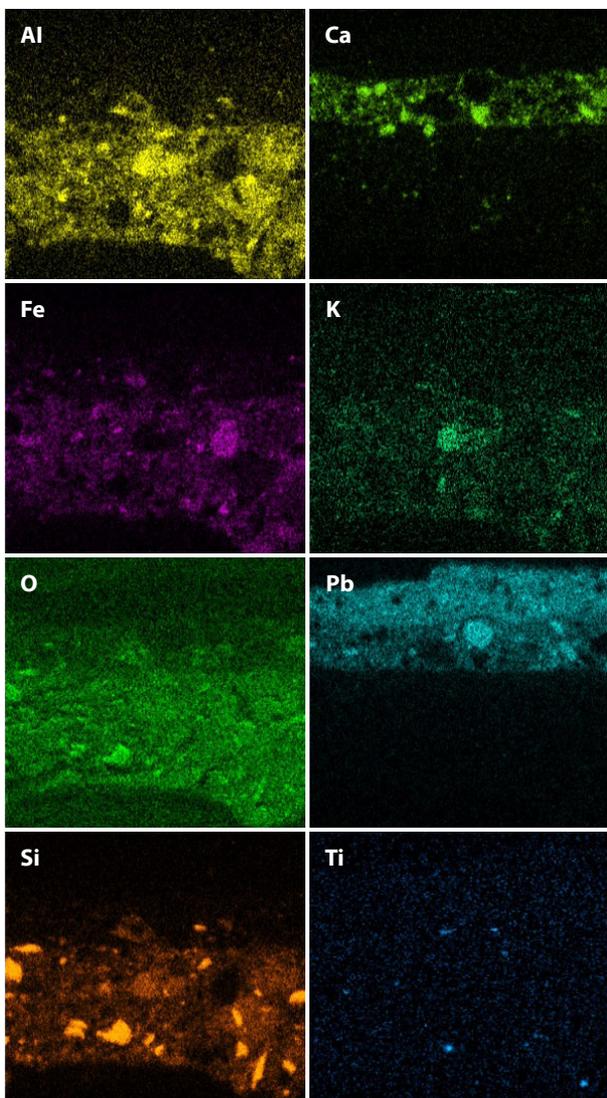


Figure 6 Elemental maps (SEM-EDX) of the cross-section showing the presence of Al, Si, Fe, K, Pb, Ca, Ti, and O in the first ground layer. EDX spectra also indicated small amounts of Mg and Na.

is indicated in the EDX spectra of an unmounted sample from the ground. For the iron oxide content, the presence of Ti and Fe in corresponding locations in the elemental maps may suggest the presence of ilmenite (FeTiO_3).¹⁵ There are large individual quartz particles (Si, O), indicative of added sand (Figs 5 and 6). A secondary electron image of a loose sample of the ground from the Hunterian painting, showing the first layer, reveals the morphology of the particles and the typical plate-like structure of clay minerals with, for example, the pseudo-hexagonal plates characteristic for kaolinite and the layered structure of illite (Fig. 7).

Although detecting clay minerals through SEM-EDX has its limitations as the particle sizes of clay minerals are extremely small and hence spectra tend to be gathered from a larger area,¹⁶ close scrutiny of elemental maps, and spectra from individual particles, correlated with the results from scientific analyses of quartz grounds by Groen, strongly suggests the use of a clay ground by Van Hoogstraten. The ground in the Hunterian painting, that is the first ground layer, contains little chalk, and the combination of several clay minerals with large quartz particles seems to indicate the possible use of a fluvial clay with added sand. The extensive brick, tile and pottery industries – mostly based on or near the embanked floodplains along the rivers Rhine and Meuse, as well as the Vecht and Oude Rijn, both of which originate from the Rhine and are close to Amsterdam – would be local sources of this type of clay to which chalk could be added if a more yellow colour was desired when fired, and/or sand that

would have rendered the tiles, bricks and pottery less prone to cracking.¹⁷ As mentioned earlier, it is likely that Rembrandt was in contact with potters through his links with the Guild of St Luke and this makes it plausible that the clay used in these quartz grounds derived from them and may already have been reworked (that is, by adding sand) to make it suitable, instead of using the raw material directly from the brick and tile industries. It is also possible that previously fired clay obtained by pulverising tiles was utilised. However, further analytical research would be needed to confirm this distinction.

Interestingly, the second, lighter-toned ground layer, consists of iron oxides with a high proportion of lead white and calcium carbonate mixed in. Lead white was often extended with chalk. De Mayerne, for example, describes common çeruse as consisting of equal parts of lead white and chalk.¹⁸ This may be the case here. Clearly, Van Hoogstraten wanted to change the tone of the surface on which he was going to paint. This second ground layer was present in all the cross-sections and does not seem to be a local 'dead-coloured' paint layer.

Past art-historical assessment of the painting

The present technical analysis has led to a re-examination of the reasoning behind the previous dating, which had been retained by scholars following Sumowski's views, including Michiel Abbing and Celeste Brusati in their publications.¹⁹ A brief look at Sumowski's catalogue, however, reveals that the overview of Van Hoogstraten's oeuvre he presents was compiled in very broad terms. He gives confident and clear (by which we would suggest) sweeping judgements that lead us to believe that his dating of this painting was based on insufficient information. Sumowski placed it within a group of eight works (cat. nos. 828–835), dating to c.1665–c.1675, which he claims originated from the artist's period in England and his final years in The Hague and Dordrecht. In the relevant section of his introductory text, although the work is not expressly mentioned, some of his remarks apply to the Hunterian painting, notably a comment on Terborch's ladies in satin. Despite noting that Van Hoogstraten's paintings

were generally 'designed and executed without inspiration', he singles out, presumably as an exception to this criticism, the Chicago *Resurrection*, a work which another commentator might connect with the Hunterian painting since both are Passion subjects, on canvases of the same size and with a similar treatment of chiaroscuro and shiny fabrics:

The majority of the artist's history and allegorical paintings were made between 1665 and 1675 (cat. 828–835); they stem from his time in England and his final years. The break with the past is rather striking: the Rembrandtesque element is now entirely abandoned in favour of a classicism which is blended with 'fine painting.' The quality of his work varies from an attractive preciousness to complete failure. His figures follow antique sculptural types but are used stereotypically and this eradicates all signs of naturalness and individuality. He paints leaving no trace of the brush, aiming to create smoothly defined surfaces. In his treatment of shimmering fabrics he is an imitator of the art of Terborch. Samuel van Hoogstraten achieves mostly a dull competency. His paintings seem designed and executed without inspiration; as if the use of recipes and rules would permit the understanding to bring forth perfection. Details become congealed in the execution and his skill as narrator, which was the strongest aspect of his earliest work, gets lost in the process. His compositions are simply formal constructions of motives. Lifeless female figures are brought together to form various subjects such as the *Annunciation to Mary* (cat. 828), or the *Education of the Virgin* (cat. 829). Where psychological responses are called for he provides no more than adequate poses and heavenward glances. His groups are sometimes provided with a meagre classical architectural setting (cat. 828). He also uses idealised landscape to provide a flat background, as in the *Penitent Magdalen* (cat. 831), to look at which is itself an act of penance. However, brilliancy of handling and subtlety of colour were certainly within Hoogstraten's grasp, something demonstrated by his *Triumph of Truth and Justice* made for Finspong Castle (cat. 830), which is the outstanding work of this phase. The *Resurrection* in Chicago (cat. 835) is also an exceptional picture, although completely disappointing

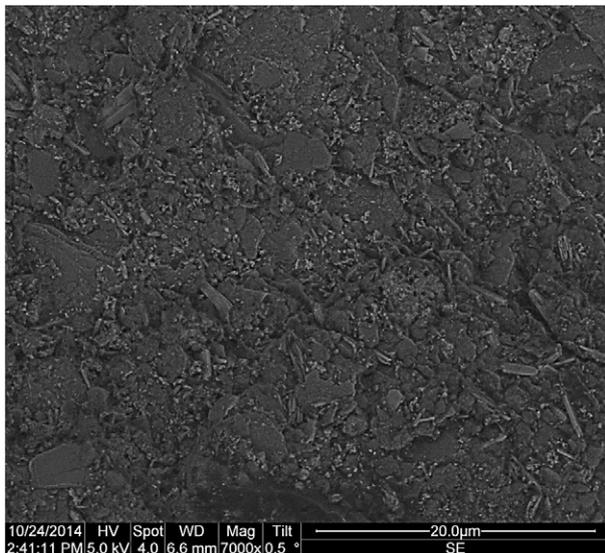


Figure 7 Secondary electron image of the lower ground taken from an unmounted sample showing the typical plate-like structures of clay minerals such as kaolinite and illite.

as a religious work. It achieves, nevertheless, an impressive arrangement which stems from the combination of a dynamic and ornamental composition, other-worldly and decorative palette, enhanced by chiaroscuro, and the delicate, fine manner in which it is painted.²⁰

Monumental as Sumowski's work on Rembrandt's pupils is, his treatment of Van Hoogstraten's history and allegorical painting is ultimately misleading. Because he groups works thematically, he loses sight of dated works with which to calibrate his generalisations. His group of eight late historical and allegorical works is small and unsatisfactorily grounded: in fact only one is dated – the *Triumph of Truth and Justice* of 1670 (cat. no. 830). One painting is attributed to Van Hoogstraten without explanation (cat. no. 834) and there is no evidence that any of these works were painted in England, where he is known to have concentrated on portraits and perspectival works. The catalogue published by Abbing in 1993, which includes only signed works, is more scientific and useful in following the development of the artist's oeuvre. Dated works, it emerges, are rare, but they are a useful indication of the distribution of portraits (which are generally late) as well as the rarer biblical works. Significantly absent from Sumowski's group of 'history and allegorical paintings' (cat. nos. 828–835) are three dated biblical works (*Adoration of the Shepherds* 1647; *Doubting Thomas* 1649; *Christ*

Crowned with Thorns 1657). These are evidence that Van Hoogstraten produced biblical subjects early on so it makes sense to consider the possibility that the Hunterian painting – and the perhaps related Chicago *Resurrection* – originate from the early Rembrandtesque phase. The biblical emphasis of Van Hoogstraten's early career comes into sharper focus if the artist's drawings are included, for which Sumowski has also provided the standard catalogue. Again, only a few of his drawings are dated, but it is worth noting the preponderance of biblical subjects: 120 of the 173 drawings categorised by Sumowski as authentic (20) or substantiated (153). These appear to be early works executed in close proximity to Rembrandt and include a related subject of the Passion, *Christ Carrying the Cross* (cat. no. 1131). The body of biblical works, taking paintings and drawings together, contains, perhaps predictably, evidence that during and immediately following his training with Rembrandt, Van Hoogstraten painted in this genre. It is puzzling, therefore, that Sumowski allowed himself to place a 'majority' of history and allegorical paintings in the later period.

Christ and the Women of Jerusalem

Provenance

The Hunterian painting is not dated but is signed at the lower left with the same monogram 'SvH' that the artist used throughout his career from as early as 1642.²¹ The work has a provenance dating back to the eighteenth century if not earlier. In 1889, G.H. Veth noted the presence of a painting by Van Hoogstraten in the collection of Johan Van der Linden van Slingeland, which was sold in 1785. The catalogue describes: 'Een Bybelsche Historie, daar Christus gedwongen word zyn Kruis te dragen, gemerkt S.v.H' (a Biblical History, where Christ is forced to bear his cross, marked S.v.H.) which can safely be assumed to refer to the Glasgow work even if the cataloguer was unaware of the identity of the artist with those initials.²² It is not known how Van Slingeland acquired the painting, but it is possible that it had passed down through the family and may have been acquired directly from Van Hoogstraten by Matthijs Pompe van Slingeland (1621–1679), one

of the artist's wealthy friends. Contact with Matthijs is documented by 1654, the year of Van Hoogstraten's *Bruylofts tafel-spel of Parnassus eer-gaf* written for Matthijs Pompe van Slingelandt's marriage to Elisabeth Musch van Waelsdorp on 22 November 1654 in The Hague, but may go back further still, thereby supporting an early production date.²³

The composition: something borrowed, something new and the *Inleyding*

Two works from Rembrandt's Passion series were delivered to The Hague in 1646 during Van Hoogstraten's time with the master. One painting, *Adoration of the Shepherds*, was clearly well known to the young artist since he reused elements of it in two works: in his painting of the same subject, dated 1647, in Dordrecht, and in the pen and wash drawing in Hamburg,²⁴ which is more carefully constructed and may postdate it. Perhaps significantly, Rembrandt did not paint or produce an etching on the subject of *Christ on the Road to Calvary*. This omission may have tempted an ambitious student to explore the subject.

In the Hunterian composition, a tight group of figures around Christ are propelling him from left to right; Christ has fallen to his knees underneath the cross just to the left of centre. A tall round-shaped citadel to the left towers above the trailing crowd of tiny people which winds into the distance. To Christ's right, the patch of dark brown earth leads upwards to a landscape. Halfway up the right-hand side, the column of people can be seen following Christ as they pass behind a fence. Above them, the eye is led past the ochre buildings of the city to the distant Mount of Olives in the shadow of dark clouds.

The picture has some quite distinctive passages that may have a bearing on the date it was painted. Although there are no known preparatory drawings, the overall composition and some details can be traced to various engravings: a method of emulating the work of past masters which Van Hoogstraten learned while studying with Rembrandt and on which he commented in the chapter on *Tekenkonst* in the *Inleyding*, explaining how pupils should learn to draw: 'Usually one puts the youth to work copying eyes, noses, mouths, ears, and all sorts of faces, as well as engravings of various sorts.' He continues: 'Study the objects not just as you

see them before you, but investigate for yourself what their virtue consists in.' He recommends using prints but cautions that 'when you have a good engraving before you, it will not always be necessary to copy it in its entirety; learn instead from an early stage to recognize its artistic virtues.'²⁵

This partial copying can indeed be seen in the Hunterian picture. The most distinctive passages in the composition are the women in the foreground and the mass of figures around Christ in the centre-left portion of the canvas. Because of the artist's desire to include a large number, the figures are crowded into too small a space, resulting in distortions of scale, notably the two horsemen behind to the left. Van Hoogstraten was aware of Rembrandt's ability to represent many different figures on a small scale and cites the example of the oil sketch of the *Preaching of Saint John the Baptist*, which he described as '*ten hoogsten prijslijk*' (the most praiseworthy), but his own figures here are too large with too little space allowed for each to stand out.²⁶ The crowding may stem, however, from the artist's choice of print source which, in the first instance, is Dürer's *Christ Bearing the Cross* from the 'Large Passion.'²⁷ The linear medium of woodcut more easily accommodates the numerous heads in the dense crowd. Although this Renaissance prototype provides the upright format and the essentials of the composition – including the position of the fallen Christ in relation to Veronica and the crowd forcing him onwards – Van Hoogstraten's principal graphic source was the engraving of *Christ Carrying the Cross* (Fig. 8)²⁸ by Goltzius, an artist whom Van Hoogstraten praises in his section on *Tekenkonst* 'upon emulating closely some great master's hand.'²⁹ This engraving provides a number of elements for the picture: Veronica, the tower behind, the mounted soldier to the left, and the figures hurrying by in the landscape centre right.

Light and dark

The distinctly Rembrandtesque lighting in *Christ and the Women of Jerusalem* has a careful construction based on exemplary formulations of the subject known from old master prints, a working method recommended by Van Hoogstraten in the *Inleyding* which, scholars now agree, often closely reflects Rembrandt's own studio practice.³⁰ Like Rembrandt's



Figure 8 Hendrick Goltzius, *Christ Carrying the Cross*, 1596–98, engraving, 205 × 139 mm, Rijksmuseum, Amsterdam, RP-P-OB-10.044.7.

small biblical history paintings of the 1640s, the composition is illuminated by pools of light such as those that illuminate the temple in Rembrandt's *Christ and the Woman Taken in Adultery* of 1644 (London, The National Gallery, NG45).

In the Hunterian composition, the light falls mainly in the foreground, on Christ and the figures around him but especially on Veronica, bottom left, dressed in shiny yellow, red and white satins, her hands clasped as she listens to Christ's words: 'Weep not for me, but weep for yourselves, and for your children. For behold the days are coming, in which they shall say...'³¹ The light also highlights Mary, placed directly behind Christ in white, raising one hand underneath her satin shawl and with a nimbus above her head. The dark tones of the foreground and background, including the ominous sky, accentuate the brightness of Christ's and Veronica's meticulously rendered fabrics.

Van Hoogstraten describes an effective use of the ground layer in the *Inleyding* that can be seen in

Veronica's satin garments in which the warm tone of this ground layer has been left exposed: 'it can happen that the priming of your canvas or panel helps in the coloration, and, assisted by a few little touches, eases your labor.'³² The whole composition makes use of a dark background to create emphasis on the protagonists of the scene. In Book 8, Chapter 8 of the *Inleyding*, on 'Of Advancing, Receding, and Foreshortening', Van Hoogstraten describes this play with tonality: 'the Italians think they can make their background work recede through *mezzotints* or half colours. Some want to bring their work forward by force with dark and black grounds, and assign that power to their piercing lights. These ascribe that trait to beautiful colours and of necessity want the grey and dull ones to recede.'³³

Conclusions

The technical research led to a re-evaluation of the late date for *Christ and the Women of Jerusalem* since the painting has a first ground layer that seems to contain clay minerals and quartz, a type of ground that has so far mainly been found in canvases prepared in Rembrandt's studio. Its use by Rembrandt began in the period in which Van Hoogstraten was his pupil. Extensive contextual research, as well as examination of Van Hoogstraten's treatise combined with information on provenance and an analysis of the composition of the painting, makes the suggested early date for *Christ and the Women of Jerusalem* plausible. The invention of the composition, using ideas and figures reliant on the great masters Dürer and Goltzius, the use of chiaroscuro and the tone of the ground reflect the methods learned from Rembrandt in the period c.1642–46, which Hoogstraten expounds in his own later treatise. Comparison with works with similar subject matter also points to an early date: there are no dated biblical subjects in Van Hoogstraten's work later than 1657. In addition, the *Inleyding* describes the efficient use of the colour of the ground by leaving it exposed locally, as well as of the effects of dark grounds to impart contrast with highlighted areas, bringing them into greater prominence. Both tonal techniques are present in the Hunterian work. A close scrutiny of the composition shows a certain

incoherence through its combination of what seem to be various types of painting: a drapery study, a history painting and experiments with chiaroscuro effects. All these observations hint at the explorations of a young painter rather than a mature artist as suggested by Sumowski's dating of 1665–75. Taking art-historical and technical information together, we propose that the Hunterian painting is early, not late, and was probably painted in the years during Van Hoogstraten's apprenticeship or immediately following his time with Rembrandt. As Van Hoogstraten comments in the *Inleyding*: 'poets may become masters by thinking, but painters become so by doing.'³⁴

Notes

1. The essentials of Samuel van Hoogstraten's production were summed up in the life written by his pupil, Arnold Houbraken in his *Grote Schouwburgh...*, The Hague, 1753. Houbraken knew that Van Hoogstraten 'studied painting with Rembrandt [because he refers to him as his second master, after the death of his father Theodore, in his book on the Art of Painting, p. 257] and for a time he kept painting in his master's manner, but after a while he moved on and eventually took up a completely different manner of painting, also devoting himself to painting portraits, a genre in which he achieved felicity, both in The Hague, where he lived for some years, and in Dordrecht. And just as Pictura bestowed talent on him, so on the other hand the goddess of poetry flattered him with glory.'
2. Sumowski, W. (1983), *Gemälde der Rembrandtschüler*, vol. II, Landau/Pfalz, Edition PVA: 1287. In Glasgow by 1963, long before Sumowski's publication, the painting was cautiously catalogued by Hamish Miles (University of Glasgow, The Smillie Collection, Glasgow 1963), as perhaps 'a late work by Hoogstraten in the Venetian manner' (surely a reference to the treatment of silks in Veronica's dress?).
3. The painting was first examined by the authors as part of a student project together with Hollie Pennington, then a postgraduate student at the Masters programme in Technical Art History at the University of Glasgow.
4. Although all the samples show the double ground, it cannot be excluded that this second layer was applied locally.
5. See Groen, K. (2014), 'Grounds in Rembrandt's workshop and in paintings by his contemporaries', in *Paintings in the Laboratory: Scientific Examination for Art History and Conservation*, ed. E. van Duijn, London, Archetype Publications: 21–49; 23, table 2.3 (Rembrandt's grounds on canvas) and table 2.7 (listing grounds used by some of his contemporaries outside his workshop).
6. Quoted in Groen 2014 (cited in note 5) 35. For De Mayerne see Sir Theodore Turquet de Mayerne (1620–1646), *Pictoria, sculptoria et quae subalternarum artium* (the 'Mayerne manuscript', Sloane MS 2052) in Berger, E. (1901), *Quellen für Maltechnik während der Renaissance und deren Folgezeit*, Munich; Van de Graaf, J. (1958), *Het De Mayerne manuscript als bron voor de schildertechniek van de Barok*, Mijdrecht, Brukker. The manuscript which is in the British Library, London, is also available digitally: http://www.bl.uk/manuscripts/FullDisplay.aspx?ref=Sloane_MS_2052.
7. Groen, K. (2014), 'Earth Matters: the origin of the materials used for the preparation of *The Night Watch*', in Groen 2014 (cited in note 5) 51–66; 53 (where she discusses the term).
8. Groen 2014 (cited in note 5) 34–5, table 2.4.
9. Groen 2014 (cited in note 5) 53–4. At the time of publication 159 paintings on canvas by Rembrandt and his circle were examined, 48 of which had a ground containing a very high proportion of quartz.
10. Maclehoose, L.S. and Baldwin Brown, G. (eds) (1960), *Vasari on Technique; By Giorgio Vasari*, New York, Dover Publications: 241–2.
11. Veliz, Z. (1986), *Artists' Techniques in Golden Age Spain: Six Treatises in Translation*, New York, Cambridge University Press: 68–9.
12. For the preparation of linen for wall hangings in the eighteenth century see Verslype, I., Verhave, J., Smelt, S., Keune, K., Sigmond, H. and van Eikema Hommes, M. (2015), 'A "painted chamber" in Beverwijk by Jacobus Luberti Augustini: novel insights into the working methods and painting practices in a painted wall-hanging factory', in *Studying 18th Century Paintings and Works on Paper* (CATS Proceedings, II, 2014), ed. H. Evans and K. Muir, London, Archetype Publications: 83–95, and Pottasch, C., Smelt, S. and Haswell, R. (2015), 'Breaking new ground: investigating Pellegrini's use of ground in the Golden Room of the Mauritshuis', *op. cit.*: 16–30.
13. Noted in Groen 2014 (cited in note 5) 53–4.
14. *Ibid.*, 55
15. We are grateful to Peter Chung, microanalyst at the Imaging Spectroscopy and Analysis Centre (ISAAC), University of Glasgow for the SEM-EDX data. Analyses were performed using a using a Carl Zeiss Sigma Variable Pressure Analytical scanning electron microscope (SEM) coupled with Oxford Microanalysis (EDX).
16. Groen 2014 (cited in note 5) 58–60.
17. *Ibid.*, 55–8; Van der Meulen, M.J., Wiersma, A.P., van der Perk, M., Middelkoop, H. and Hobo, N.

- (2009) 'Sediment management and the renewability of floodplain clay for ceramics', *Journal of Soils and Sediments* 9: 627.
18. See, for example, Stols-Witlox, M. (2011), "'The heaviest and the whitest": lead white quality in north western European documentary sources, 1400–1900', in *Studying Old Master Paintings: Technology and Practice*, ed. M. Spring, London, Archetype Publications: 284–94.
 19. Abbing, M.R. (1993), *De Schilder & Schrijver Samuel van Hoogstraten 1627–1678: Eigentijdse bronnen & oeuvre van gesigneerde schilderijen*, Leiden, Primavera Pers.: 142. no 43; Brusati, C. (1995) *Artifice & Illusion: The Art and Writing of Samuel van Hoogstraten*, Chicago, University of Chicago Press: 355, no. 52. Both authors include a catalogue of paintings by Samuel van Hoogstraten.
 20. Sumowski 1983 (cited in note 2) 1287–8. With thanks to Christian T. Seifert for help with the translation.
 21. Abbing 1993 (cited in note 19) 34 (Chronologie 9), reproduces two etchings by Hoogstraten, signed and dated 1642, for a medical book by Johan van Beverwijck on scurvy.
 22. Veth, G.H. (1889), 'Aanteekeningen omtrent eenige Dordrechtse Schilders, XVII, Samuel van Hoogstraten', *Oud Holland* 7: 129–48. The entry for the painting is on p. 172, no. 658 in P. Yver's *Catalogus van een uitmuntend cabinet konstige en plaisante schilderyen, tekeningen, prentkonst, beeld-werk en rariteiten, van de voornaamste meesters ... nagelaaten door wylen den Wel-Edelen Heer Johan van der Linden van Slingeland : het welk verkogt zal worden binnen de stad Dordrecht, ten sterfhuize op de Waale Vest, ... den 22. Augustus 1785 en volgende dagen*, Dordrecht, Pieter van Braam, 1785. The catalogue is available online through the Hathi Trust Digital library: <http://catalog.hathitrust.org>.
 23. Abbing 1993 (cited in note 19) 84 (Bibliografie 9). Abbing reproduces a portrait of an unidentified man, dated 1650, whose attribute is a pump, which could be an allusion to the name of Matthijs Pompe van Slingelandt.
 24. Sumowski 1983 (cited in note 2) *Drawings*, cat. no. 1102.
 25. Van Hoogstraten, S. (1678), *Inleyding tot de hooge schoole der schilderkonst*, Rotterdam, Chapter 5: 'Men stelt de jeucht gemeenlijk aen't nateykenen van oogen, neuzen, monden, ooren, en verscheyderley tronien, en verder, na prenten van alderley slach. [...] Komt u een goede prent voor, 't en zal niet altyts noodich zijn, dat gy dezelve in al haer deelen nateykent, maer leer al vroegh de deuchden der konst onderscheyden. [...] Volch de dingen, niet alleen, zoo als gy die voor u ziet, maer onderzoekt zelf, waer in derzelve deucht bestaat.' English translation: *Samuel van Hoogstraten's Introduction to the Academy of Painting: or, The Visible World*, C. Brusati (ed.), Jaap Jacobs (transl.), Getty Publications, Los Angeles, 2021, 80.
 26. Van Hoogstraten 1678 (cited in note 25) 183, English translation: Brusati 2021 (cited in note 25), 13, and 225.
 27. Von Bartsch, A. (1803–21), *Der Peintre-graveur* (21 vols), vol. VII.117.10, Vienna.
 28. Leesberg, M. and Leeftang, H., *The New Hollstein Dutch & Flemish Etchings, Engravings and Woodcuts 1450–1700* – Hendrick Goltzius, 4 volumes, 25.
 29. Van Hoogstraten 1678 (cited in note 25) 75: 'en Goltsius op eenige groote Meesters hand eigentlijk na te volgen'. English translation Brusati 2021 (cited in note 25), 130.
 30. See the discussion of the *Inleyding* as well as Van Mander's text by Van de Wetering, E. (2016), *Rembrandt: The Painter Thinking*, Amsterdam, Amsterdam University Press: 105, 117. See also Hermens, E. (2012), 'The passion in paint, a technical investigation', in *Rembrandt and The Passion*, P. Black and E. Hermens, Munich, Prestel Verlag: 101–34.
 31. St Luke XXIII: 28–31.
 32. Van Hoogstraten 1678 (cited in note 25) 321: 'Zoo kan 't ook gebeuren dat de grondverwe uwes doeks of paneels in't koloreeren te pas komt, en met eenige duwkens geholpen, uwen arbeyt verlicht.' English translation Brusati 2021 (cited in note 25), 343.
 33. Van Hoogstraten 1678 (cited in note 25) 306: 'd' Italiaenen meenen haer achterste werk door mezetinten of halfkleuren te rug te schuiven. Zommige willen met donkere en zwarte gronden haer werk met gewelt doen voorkomen, enschrijven haere steekende lichten dat vermogen toe. Deze geeven die deugt aen de schoone verwen, en willen dat de graeuwe en vuile nootzakelijk wechwijken.' English translation Brusati 2021 (cited in note 25), 332.
 34. Van Hoogstraten 1678 (cited in note 25) 321: 'Poëten mogen door denken, maer Schilders moeten door doen, Meesters worden.' English translation Brusati 2021 (cited in note 25), 343.

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Should prints be redated because of watermark evidence? Some examples and considerations

Erik Hinterding

ABSTRACT This article addresses the question as to whether the study of watermarks in the paper used to make prints can be used to determine the date when those prints were made. In the case of Rembrandt's etchings, this poses the thread of a circular argument as in recent research his etchings provided the clues for dating the paper on which they are printed. Can those watermarks subsequently be used to redate the etchings? As it turns out, they can – or at least they can provide strong arguments to reconsider the traditional dating as demonstrated by a number of examples.

Introduction

In the last decades a new method has been developed allowing us to date quite precisely the impressions of Rembrandt's etchings with the help of their watermarks.¹ Since this line of enquiry began, a methodological question has needed to be resolved: should prints be redated because of watermark evidence? The problem here is the threat of a circular argument: if we first use prints to date the watermarks occurring in the paper on which they are printed, can we then use the same watermark to redate the prints? While compiling a dissertation on the subject, this question remained a matter of concern, resulting in a reluctance to redate prints on the basis of watermark evidence. As the subject developed, however, it was realised that there are sometimes good reasons to redate prints based on these observations.

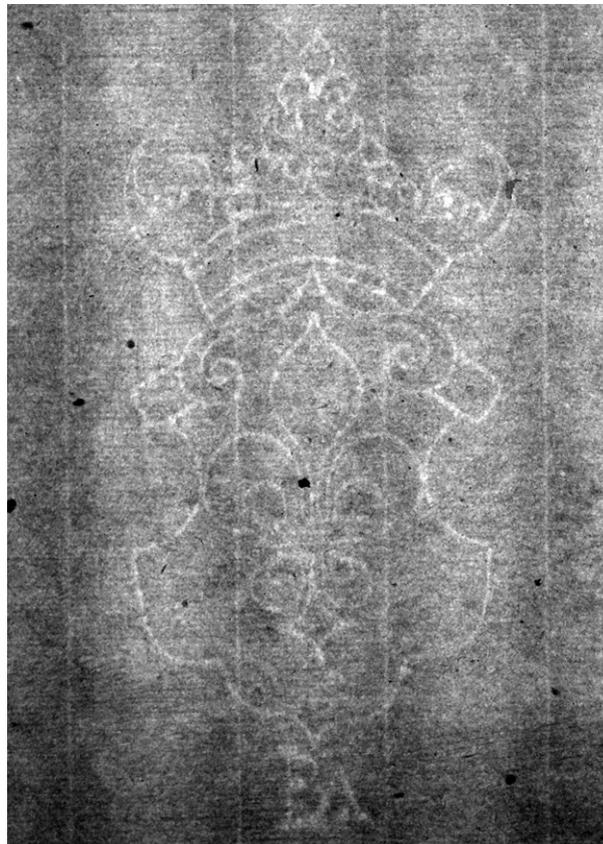


Figure 1 *Strasbourg lily with initials BA*, variant A.a.



Figure 2 Rembrandt, *The Great Jewish Bride*, c.1635, etching, Rijksprentenkabinet, Amsterdam.



Figure 3 *Strasbourg Bend*, variant D.a.

Dating of the watermarks on Rembrandt's etchings

Before a number of examples are discussed, it is necessary to explain briefly how the watermarks on Rembrandt's etchings are dated. Traditionally, archival documents, often notarial deeds, are compared. As notaries are large-scale consumers of recently manufactured paper, it is assumed that the date written on the document can be taken as the date for the watermark in the paper. Famous watermark handbooks such as Briquet, Churchill, Heawood and more recently Laurentius date watermarks using this method.² However, for Rembrandt a completely different method has been developed, starting by establishing which prints bear exactly the same watermark. From this group of works on the same paper, we then try to determine when they must have been printed by searching for proof states and particularly fine, early impressions within the group because it is reasonable to assume that those rare impressions were printed during the creation of the print, and that they cannot be re-strikes, printed later.³

Strasbourg lily with initials BA, variant A.a.

A first example that may clarify this method of dating is the watermark *Strasbourg lily with initials BA*, variant A.a. (Fig. 1) that is found in a considerable number of prints, here listed in chronological order:⁴

- › *The Artist's Mother* (NHD. 5ii; B. 354), 1628
- › *The Small Lion Hunt* (NHD. 28; B.115), c.1629
- › *Self-portrait, Frowning* (NHD. 68iii; B. 10), 1630
- › *Bearded Man in a Furred Oriental Cap* (NHD. 85v; B. 263), 1631
- › *The Good Samaritan* (NHD. 116iv; B. 90), 1633
- › *Self-portrait in a Plumed Cap* (NHD. 135iii; B. 23), 1634
- › *The Crucifixion* (NHD. 143i; B. 80), c.1635
- › *The Fourth Oriental Head* (NHD. 152iii; B. 289)
- › *The Great Jewish Bride* (NHD. 154ii, iii; B. 340), 1635-iii.

The impressions crucial for dating this entire group are the two of *The Great Jewish Bride*, in the second and third states (Fig. 2). Both are unfinished states,



Figure 4 Rembrandt, *The Three Crosses*, c.1653, drypoint, Rijksprentenkabinet, Amsterdam.

the third state being dated 1635 in the plate for the first time. They must have been printed in that year, indicating that this paper was in use then. Without exception all the other prints are dated either 1635 or earlier, therefore these impressions must be reprints of older copperplates.

A second example demonstrating how impressions of Rembrandt's etchings can be dated is provided by the *Strasbourg Bend*, variant D.a watermark (Fig. 3), which is found in impressions of:

- › *The Death of the Virgin* (NHD. 173ii; B. 99), 1639
- › *A Scholar in his Study ('Faust')* (NHD. 270i; B. 270), c.1652
- › *Saint Jerome in an Italian Landscape* (NHD. 275ii; B. 104), c.1653
- › *The Three Crosses* (NHD. 274i, ii, iii, iv; B. 78), 1653-iii.

In this case too, the last print – *The Three Crosses* – holds the clue for dating the entire group (Fig. 4): as impressions of all four states occur on the same paper, and only the third state is dated 1653, the paper must have been in use in 1653. This is particularly interesting since it demonstrates that the completely reworked fourth state should also be dated to 1653.⁵ The impressions of other etchings on the same paper should be considered as reprints of copperplates made earlier (or at around the same time).

Using this method of dating, we have learned that Rembrandt produced his prints in small editions and often reprinted from his copperplates. There are editions of the same print from 1631, 1632, 1634, 1635, and so on.⁶ Analysis of the results of the research into the watermark has shown that Rembrandt used approximately six different kinds

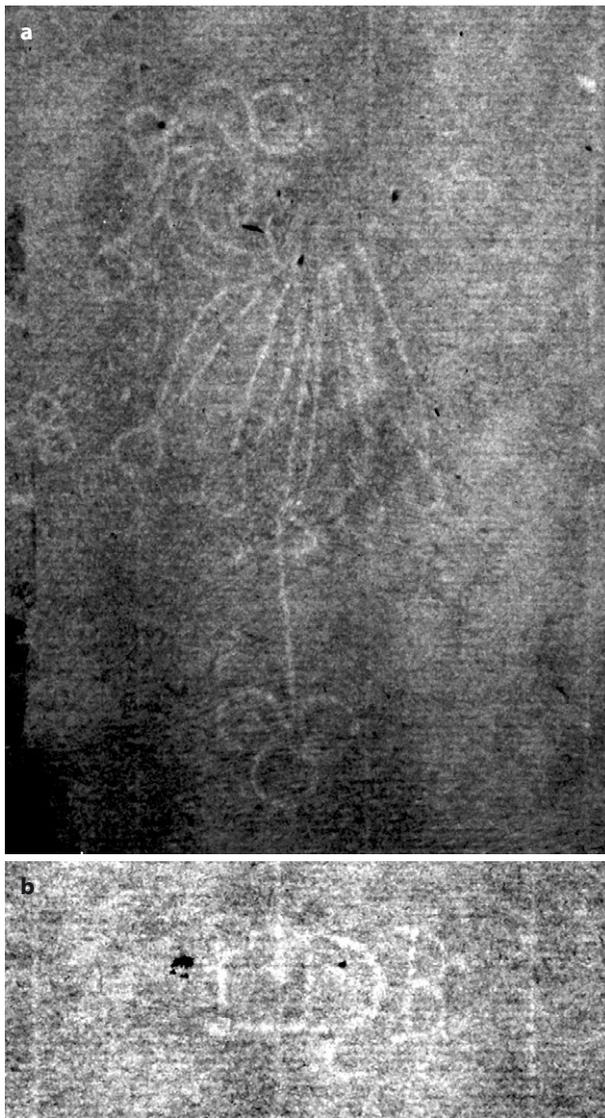


Figure 5 *Foolschap with five-pointed collar*, variant I.a. with its Countermark PDB'.a.

over the course of a year, leading to the conclusion that he must have purchased his paper in fairly small quantities (per squire or a few squires at the time). It can also be concluded that these different types of paper did not last long in Rembrandt's workshop – only in some very rare cases has paper been found (recognisable by its watermark) that must have been in use over an extended period of time, usually several years. Without exception, these proved to be larger paper formats: median, royal and imperial size. In most cases, however, there is no indication that the paper was retained over a long period.⁷ This is an important conclusion for the current topic being discussed: i.e. if the watermarks are dated by the prints that occur

on that particular paper, can the prints be redated using the same watermark? To elaborate on this question, a few examples are given. The watermark *Foolschap with five-pointed collar*, variant I.a. with its Countermark PDB'.a. (Fig. 5) is in a regular size paper (not large format) that is found in impressions of a considerable number of prints, as follows:

- › *The Small Lion Hunt* (NHD. 29; B. 116), c.1629
- › *The Rat Catcher* (NHD. 111iii; B. 121), 1632
- › *The Ship of Fortune* (NHD. 123ii; B. 111), 1633
- › *Saskia with Pearls in her Hair* (NHD. 136; B. 347), 1634
- › *Self-portrait Leaning on a Stone Sill* (NHD. 171ii; B. 21), 1639
- › *The Flute Player* (NHD. 211iv; B. 188), 1642-ii
- › *Six's Bridge* (NHD. 222iv; B. 208iii), 1645
- › *Medea* (NHD. 241iv; B. 112iv), 1648
- › *Cottage with a White Paling* (NHD. 246i, ii, iii; B. 232), 1648-iii.

The most revealing print is the last, *Cottage with a White Paling*, which is found on this paper in the first, second and third state, and dated 1648 only in the third and final state,⁸ so there can be no doubt that Rembrandt was using paper with this watermark in 1648. It is therefore puzzling that this watermark is also found in one more print, the *Landscape with Sportsman and Dogs* ('het jagertje') (NHD. 245ii; B. 211) (Fig. 6). Rembrandt never inscribed the copperplate with his name or a year, but for many years it has been dated to around 1653.⁹ Taking into account the fact that Rembrandt most certainly used the paper on which it was printed in 1648, this traditional date can be interpreted in two ways: either Rembrandt must have used this paper over a longer period of time (1648–1653) or the traditional date of the print must be incorrect. We have seen that the first possibility is not impossible, but very rare, and considering the size of the paper highly unlikely. Cynthia Schneider in her 1990 catalogue on Rembrandt's landscapes has suggested that the print is probably from 1645–48.¹⁰ But more conclusive evidence that it should be dated to 1648 was found only recently, and this has not been mentioned in the *New Hollstein Rembrandt* volumes published in 2013.¹¹ In the Dutuit Collection in Paris there is an impression of the first state of *Landscape with Sportsman and*



Figure 6 Rembrandt, *Landscape with Sportsman and Dogs* (*het jagertje*), c.1648, etching and drypoint, Rijksprentenkabinet, Amsterdam.

Dogs with the watermark *Strasbourg lily*, variant D'a. (Fig. 7),¹² which is also found in impressions of the following:

- › *Jan Six* (NHD. 238v; B. 285), 1647-ii
- › *The Hundredguilderprint* (NHD. 239i, ii; B. 74), c.1648
- › *Self-portrait Etching at a Window* (NHD. 240ii; B. 22), 1648-ii
- › *Medea* (NHD. 241iii, iv; B. 112), 1648-iv
- › *St Jerome beside a Pollard Tree* (NHD. 244iii; B. 103), 1848-iii.

As with the *Landscape with Sportsman and Dogs*, every one of these prints occurs on this paper in an early state, before the final state, and all these impressions can be dated to 1648. This leaves no doubt that the *Landscape with a Sportsman and Dogs*,

traditionally dated to around 1653, should in fact also be dated to c.1648.

There are a few other examples that were found in a completely different way. A study of the watermarks in Rembrandt's prints reveals a clear and repetitive pattern. From the very beginning of his career as an etcher, the earliest impressions of his prints are on paper with the same watermark as other etchings, including those made around the same time, but in most cases there are also numerous reprints of older copperplates, as discussed above. His latest prints always occur on the same paper as all kinds of reprints from older copperplates – that is to say, prints made, for example, in 1652, are found on the same paper as prints Rembrandt made more than 20 years before.¹³

It is therefore highly remarkable that in 1654 this very distinctive and widespread pattern completely

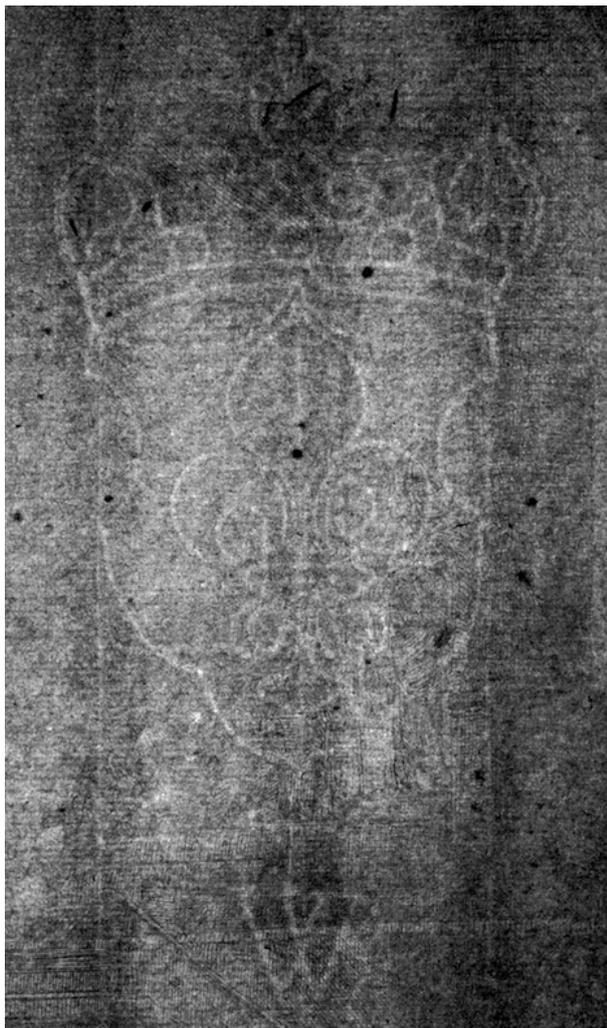


Figure 7 *Strasbourg lily*, variant D'a.

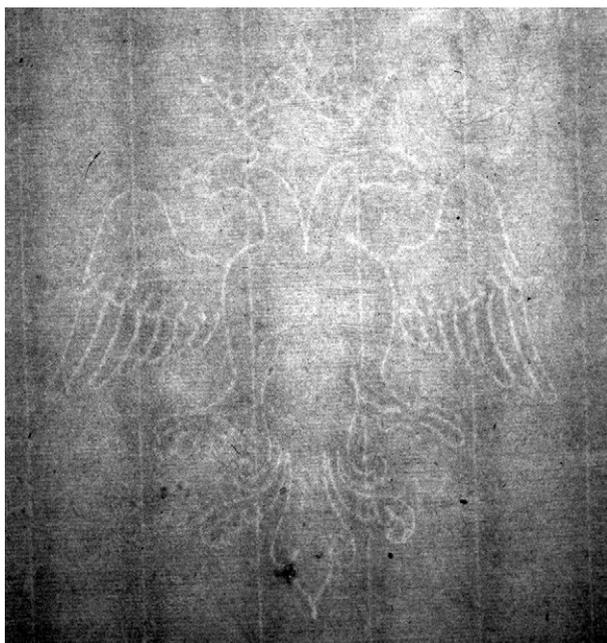


Figure 8 *Double-headed Eagle*, variant D.a.

disappears. From then on, the watermarks in the prints made by Rembrandt are usually found in other impressions of the same etching only. For example, the watermark *Strasbourg lily*, variant E.c., dated to 1654, is present in impressions of the first and second state of *Christ at Emmaus* but it does not occur in any other prints. Some watermarks from this period can be found in other prints but they are always etchings that Rembrandt made around the same time. For example, the *Double-headed Eagle*, variant D.a. (Fig. 8) appears in impressions of:

- › *Jan Lutma, Goldsmith* (NHD. 293; B. 276i), 1656-ii
- › *Abraham Francen, Apotecary* (NHD. 301v; B. 273), c.1657
- › *Christ and the Woman of Samaria: An Arched Print* (NHD. 302i; B. 70), 1657

Again these are all early states, confirming that they must have been printed on this particular paper around 1657. These results are very intriguing as they demonstrate that from 1654 onwards, the copperplates previously made by Rembrandt were no longer reprinted with the newest prints as had been his custom up to that date. It clearly suggests that Rembrandt's stock of 'old' copperplates had become separated from the etchings he produced after 1654.¹⁴

What this means is not entirely certain. These are the years immediately before his bankruptcy, and it is very possible that Rembrandt pawned his copperplates or possibly even sold them. It is certainly remarkable that shortly afterwards the main print dealers in Amsterdam appear to own copperplates by Rembrandt. Dancker Danckerts certainly did while Rembrandt was still alive, and it is highly likely that Clement de Jonghe, the most famous of the seventeenth-century publishers who owned copperplates by Rembrandt, obtained his plates during the artist's lifetime – as did Nicolaus Visscher and Frans Carelse, around the same time.¹⁵

However, if after 1654 Rembrandt's older copperplates were separated from the new ones he made, then no pre-1654 prints should be found at all on the same paper as early impressions of post-1654 prints. In general, this turns out to be true: of 2700 impressions carrying watermarks, only two impressions of prints presumed to be made before 1654 are on the same paper as early impressions of



Figure 9 Rembrandt, *Adoration of the Shepherds: A Night Piece*, c.1657, etching and drypoint, Rijksprentenkabinet, Amsterdam.

prints made after this date. One impression of the fifth state of the *Adoration of the Shepherds: A Night Piece* (NHD. 300; B. 46v) (Fig. 9) is on the same paper with a *Double headed eagle* discussed above. It was traditionally dated to c.1652 – only Ludwig Münz believed it should be c.1656–57.¹⁶ The fact that an impression of the fifth state, i.e. an early impression, is on the same paper as the first states of *Jan Lutma, Goldsmith* (1656) and *Christ and the Woman from Samaria* (1657) clearly indicates that the *Adoration of the Shepherds* should also be placed around 1656–57. In style and execution it fits far better around that time than in the early 1650s. Its dark tonality is very similar to the portrait of *Abraham Francen, Apotecary* (c.1657) (Fig. 10), and just like this portrait, the *Adoration of the Shepherds* was elaborated in a large number of proofs and both show the same type of reworking in later states.

The other exception is an impression of *Christ Preaching* (*La petite tombe*) (NHD. 298; B. 67), which traditionally is dated around 1652, probably because of a similarity to a drawing in an album in the Six Collection in Amsterdam.¹⁷ One impression is found with a countermark IHS, variant B.a. that also occurs in several impressions of *St Francis Beneath a Tree, Praying* (NHD. 299ii; B. 107).¹⁸ In this case also a date

of around 1657 is much more convincing: its style and the emphasis on horizontal and vertical lines compares very well with the *Christ and the Woman of Samaria: An Arched Print* of 1657.

There are two more prints in which the watermarks argue for a revision of the traditional dating, but in yet another way than the examples discussed above. The watermark *Strasbourg lily with initials LC.a.* (Fig. 11) was found in four landscapes

- › *View of Amsterdam from the Kadijk* (NHD. 203; B. 210), c.1640
- › *The Windmill* (NHD. 200; B. 233), 1641
- › *Cottages and Farm Buildings with a Man Sketching* (NHD. 201; B. 219), c.1645
- › *Cottage beside a Canal with a View of Ouderkerk* (NHD. 202; B. 228), c.1645

In this group *The Windmill* is the only one dated in the plate, as 1641.¹⁹ In these cases it is interesting to note how the watermarks conflict with the traditional dating. For both landscapes from around 1645, it is clear that the watermark *Strasbourg lily, LC.a.* occurs in the best impressions. The *View of Ouderkerk* displays heavy grain in the sky (Fig. 12), and the impressions on this paper of *The Windmill* (dated 1641) are also



Figure 10 Rembrandt, *Abraham Francen, Apothecary*, c.1657, etching and drypoint, Rijksprentenkabinet, Amsterdam.

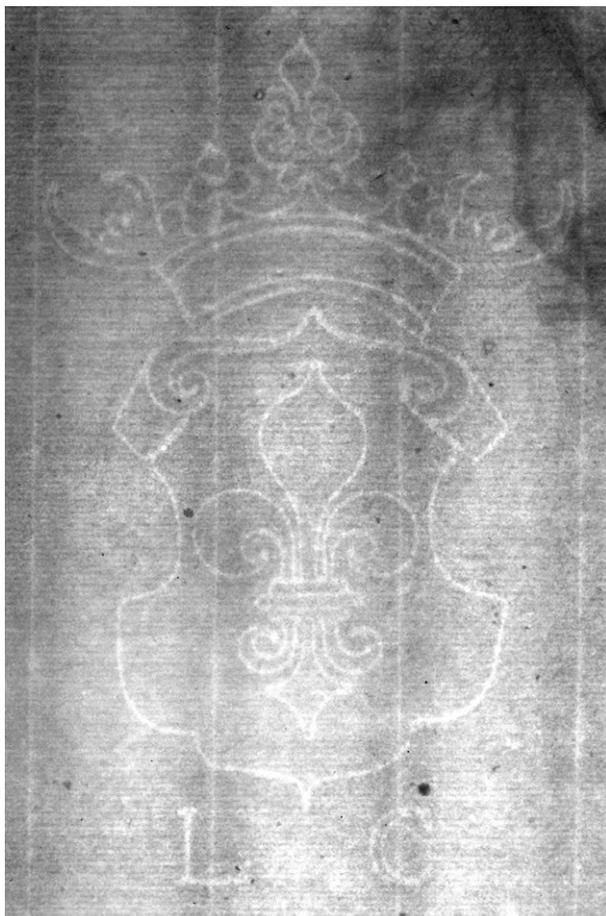


Figure 11 *Strasbourg lily with initials LC.a.*

very good. But there is an oddity that has only been noticed fairly recently:²⁰ all four landscapes are comparatively large, meaning that they almost always display a watermark – indeed, a great number of watermarks are known. It is therefore striking that for *The Windmill* no first edition was known. We have been aware of many watermarks from the editions of 1645, 1646, 1650, and so on, but a watermark identifying the first edition from 1641 was lacking. The print is dated in the copperplate to 1641, so how can this have arisen? How can the first edition be missing?

Once the solution is known, it is difficult to understand why it could have been missed for so long. Both the *Cottage and Farm Buildings* and *View of Ouderkerk*, traditionally placed around 1645, are not dated in the copperplate although some authors have believed it should be earlier. Once again, Ludwig Münz is among the scholars who suggested it belonged to 1641–42, while Cynthia Schneider opted for 1642–43.²¹ Although lone voices for quite some time, the watermarks indicate that they were on the right track. With so many watermarks in the impressions of *The Windmill*, it is inconceivable that the first edition would be missing – it is in fact the *Strasbourg lily*, LC watermark under discussion that identifies the earliest edition. This implies that the



Figure 12 Rembrandt, *Cottage beside a Canal with a View of Ouderkerk*, c.1641, etching, Rijksprentenkabinet, Amsterdam.

Cottage and Farm Buildings and *View of Ouderkerk*, printed on the same paper as the first edition of *The Windmill*, should also be dated around 1641 rather than 1645, as Münz and Schneider had suspected in their work. Comparing the style and execution of these four landscapes, it is difficult to see how it could be argued that the *Cottage and Farm Buildings* and *View of Ouderkerk* were made four years later than the other two.

Conclusions

The central question posed in the Introduction was: if we first use prints to date the watermarks occurring in the paper on which they are printed, can we then use the same watermark to redate the prints? Having discussed several examples where the watermarks raise questions concerning the date of the prints found on the same paper, we can conclude that there is actually little reason to worry about a possible circular argument. It

is not the watermarks that dictate a new date for the prints but they do expose irregularities in the general pattern thereby drawing attention to the odd ones out within a group of prints. It is our task to come up with an explanation, and this can lead to the conclusion that either the print or the watermark is not dated correctly (with further consequences). We then need to come up with additional arguments to support a new dating of the print or prints. The most important conclusion, however, is that it is not the watermarks themselves that dictate the outcome – they only highlight discrepancies in what we would expect to find. There is no circular argument and watermarks can be extremely helpful in establishing the dates for Rembrandt's prints.

Notes and references

1. Laurentius, Th., Hinterding, E., van Hugten, H. and Filedt Kok, J.P. (1992) 'Het Amsterdamse onderzoek

- naar Rembrandts papier. Radiografie van de watermerken in de etsen van Rembrandt', *Bulletin van het Rijksmuseum* 40: 353–84; Ash, N. and Fletcher, S. (1998), *Watermarks in Rembrandt's Prints. With a Contribution by Jan Piet Filedt Kok*, Washington DC, National Gallery of Art; Hinterding, E. (2001) *Rembrandt als etser. Twee studies naar de praktijk van productie en verspreiding* (with a summary in English), dissertation, University of Utrecht. In slightly modified form published in English as: Hinterding, E. (2006), *Rembrandt as an Etcher: The Practice of Production and Distribution*, 3 vols, Ouderkerk aan den IJssel, Sound and Vision Publishers.
2. Briquet, C.M. (1907), *Les Filigranes. Dictionnaire historique des marques du papier dès leur apparition vers 1282 jusqu'en 1600*, 4 vols, Paris/ London/ Leipzig/ Amsterdam/ Rome/ Madrid; Churchill, W.A. (1935), *Watermarks in Paper in Holland, England, France, etc. in the XVII and XVIII Centuries and their Interconnection*, Amsterdam; Heawood, E. (1950), *Watermarks, Mainly of the 17th and 18th Centuries*, Hilversum, Paper Publications Society; Laurentius, Th. and Laurentius, F. (2007), *Watermarks, 1600–1650, found in the Zeeland Archives*, Houten, Hes & de Graaf Publishers BV, 2007; Laurentius, Th. and Laurentius, F. (2008) *Watermarks 1650–1700 found in the Zeeland Archives*, Houten, Hes & de Graaf Publishers BV.
 3. An exhaustive explanation of the method can be found in Hinterding 2006 (cited in note 1) 21–7.
 4. B. in the numbers refers to A. Bartsch (1797), *Catalogue raisonné de toutes les estampes qui forment l'oeuvre de Rembrandt*, Vienna. Bartsch's numbering is also used in White, Chr. and Boon, K.G. (1969) *Rembrandt's Etchings: An Illustrated Critical Catalogue in Two Volumes*, Amsterdam/ London/ New York, Van Gendt & Co. NHD refers to Hinterding, E. and Rutgers, J. (2013), *The New Hollstein Dutch & Flemish Etchings, Engravings and Woodcuts 1450–1700* (7 vols), vol. 25, *Rembrandt*, Ouderkerk aan den IJssel, Sound and Vision Publishers.
 5. Hinterding, E., Luijten, G. and Royalton-Kisch, M. (2000–2001), *Rembrandt the Printmaker*, London, British Museum/ Amsterdam, Rijksmuseum: 297–304.
 6. Hinterding 2006 (cited in note 1) vol. 2, 244–332.
 7. *Ibid.*, vol. 1, 47–58.
 8. Hinterding, E. (2008) *Rembrandt Etchings from the Frits Lugt Collection*, 2 vols, Bussum and Paris, Thoth: 388–9.
 9. See among others White and Boon (cited in note 4) no. 211; Biörklund, G. (1955), *Rembrandt's Etchings, True and False*, Stockholm/ London/ New York, George Biörklund/ Esselte Aktiebolag: no. 53-1; Münz, L. (1952) *Rembrandt's Etchings*, London, Phaidon: no. 166 (1652); Hind, A.M. (1923), *A Catalogue of Rembrandt's Etchings, chronologically arranged*, 2 vols, London, Methuen & Co.: no. 265.
 10. Schneider, C. (1990), *Rembrandt's Landscapes: Drawings and Prints*, Washington DC, National Gallery of Art: no. 33.
 11. Hinterding and Rutgers 2013 (cited in note 4).
 12. Renouard de Bussierre, S. (2006–2007), *Rembrandt. Eaux-fortes*, Paris, Petit Palais: no. 147 (watermark in the appendix under no. 71).
 13. Hinterding 2006 (cited in note 1) vol. 1, 122–4.
 14. *Ibid.*, 135–9.
 15. Hinterding, E. (2011), "The incomparable Reinbrand": Rembrandt als onafhankelijk prentmaker in 17^{de}-eeuws Amsterdam', in *Gedrukt tot Amsterdam. Amsterdamse Prentmakers en -uitgevers in de Gouden Eeuw*, ed. E. Kolfin and J. van der Veen, Zwolle and Amsterdam, Museum het Rembrandthuis, 192.
 16. Münz 1952 (cited in note 9) no. 237.
 17. For this drawing, see S. Slive (2009), *The Drawings of Rembrandt: A New Study*, London, Thames and Hudson, 188–90.
 18. Hinterding 2006 (cited in note 1) vol. 1, 139–41.
 19. See Biörklund 1955 (cited in note 9) nos. 45-1 and 45-2; Münz 1952 (cited in note 9) no. 148; Hind 1923 (cited in note 9) nos. 212 and 213.
 20. Hinterding 2008 (cited in note 9) nos. 171 and 180.
 21. Münz 1952 (cited in note 9) no. 149; Schneider 1990 (cited in note 10) no. 7.

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'The highest degree of excellence': how Reynolds improved Rembrandt

Claudia Laurenze-Landsberg and Katja Kleinert

ABSTRACT

In 1883, when the Gemäldegalerie, Berlin, purchased two paintings then considered to be by Rembrandt – *Susanna and the Elders* and *Daniel's Vision* (now attributed to Willem Drost) – they were said to be in good condition with little in the way of later interventions. Recent technological analysis alongside art historical studies did not support this over-optimistic assessment. In the eighteenth century, works were owned by Sir Joshua Reynolds, who was interested in old masters and regularly 'restored' paintings in his possession, including it seems from the evidence the two paintings in this study. In the case of *Susanna and the Elders*, Reynolds extensively reworked its overall appearance by erasing entire sections or thinning the paint only to subsequently reapply it, restorations or revisions that were certainly not necessary. For *Daniel's Vision*, next to nothing remains of the original and a comparison with *Susanna and the Elders* suggests that again the revisions most likely stem from Reynolds's own hand.

Introduction

In 1883, the Berlin Gemäldegalerie purchased two paintings considered to be works by Rembrandt: *Susanna and the Elders* (Fig. 1) and *Daniel's Vision* (Fig. 2).¹ The art historian and critic Adolf Rosenberg (1850–1906) confidently asserted that these paintings had stood 'under an auspicious star ...' They are equally as untouched by any damage as by any other hand!² Unfortunately, however, recent examinations of these paintings within the research of Rembrandt's works in Berlin³ do not support this overly optimistic assessment.

A suspicion

In the second half of the eighteenth century, both works came into the possession of the British painter

Sir Joshua Reynolds (1723–1792) where they were to remain together from this point onwards. Not only are they linked very closely with regard to their provenance but they also suffered similar fates in other respects. It is now impossible to trace back exactly when *Daniel's Vision* became part of Reynolds's collection. In April 1791, the painting was presented as a loan by the artist at a public display called *Ralph's Exhibition*,⁴ but presumably it was acquired much earlier. Reynolds undoubtedly saw the painting, today attributed to Rembrandt's pupil Willem Drost (1633–1659),⁵ as a particularly outstanding work of Rembrandt and estimated its worth as much higher than the *Susanna* painting.⁶

Susanna and the Elders was still in the possession of the writer and politician Edmund Burke (1729–1797) in May 1769. At this time it was reproduced in a detailed and presumably accurate mezzotint by Richard Earlom (1743–1822), which mentions 'Esqu. Birk' as the owner of the painting.⁷ Just a month later,



Figure 1 Rembrandt, *Susanna and the Elders*, 1647, oil on wood, 76.6 × 92.7 cm, Berlin, Gemäldegalerie, Staatliche Museen zu Berlin, inv. no. 828 E. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Christoph Schmidt.



Figure 2 Willem Drost (attributed to), *Daniel's Vision*, oil on canvas, 99 × 119 cm, Berlin, Gemäldegalerie, Staatliche Museen zu Berlin, inv. no. 828 F. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Christoph Schmidt.



Figure 3 Richard Earlom (after Rembrandt), *Susanna and the Elders*, 1769, mezzotint, 455 × 535 mm (plate), Berlin, Kupferstichkabinett, Staatliche Museen zu Berlin, inv. no. 738-32, 739-32. Photo © Staatliche Museen zu Berlin, Kupferstichkabinett/Jörg P. Anders.

in June, the painting ended up in Reynolds's collection, as confirmed by the second state of Earlom's mezzotint (Fig. 3).⁸ When comparing the mezzotint to the painting today, it quickly becomes clear that originally the painting's design must have been considerably more sophisticated: an astonishing number of details can be found in the mezzotint that are no longer present on the panel. Two maidservants were discernible in front of the palatial architecture in the background, as was lush vegetation including two palm trees, an overgrown wall, and a peacock at the foot of the large tree in the centre. The architecture

featured more details and had been executed in a more structured manner. The foliage of individual trees and greenery was clearly distinguishable. Behind Susanna, a cavern in the shape of a shell could be seen but only with the aid of the mezzotint does the edge of the water bordering the palatial garden, delineated by a high natural stone wall, make sense. Details in the costumes, such as fringes and decorations, or the folds in Susanna's robe, were worked out more lavishly and in a more nuanced manner. What had happened to the painting to cause its present appearance to differ so drastically from the state it was in when recorded in 1769?

The areas mentioned above already stood out as different from the rest of the painting from our very first technical examination. Their relatively extensive, rather rough execution does not harmonise at all well with the original, highly detailed, fully worked out and pleasingly designed areas of the painting. It soon became apparent that these areas had been altered at a later date. This was indicated by a strong darkening registered through neutron autoradiography, judged to have been caused by the presence of the element antimony in the paint. The yellow lead antimonate pigment, Naples yellow, did not become used widely until the eighteenth century which is probably when this part must have been added (Figs 4 and 5).⁹ Since the reworking is notably accomplished, it could reasonably be assumed that it was done by a practised hand, perhaps even by a professional painter. Suspicion therefore quickly fell

on Reynolds, the only painter who had possessed the paintings after 1769.¹⁰

Sir Joshua Reynolds is generally considered to have been the most renowned British painter of the eighteenth century. He was already well known during his lifetime for his technical and material experiments¹¹ and keen interest in old master paintings. Today, however, the way Reynolds treated them would undoubtedly be characterised as both disrespectful and unethical. The painter purchased old masters at every opportunity in order to study their layer build-up among other motivations, occasionally by completely removing all the paint layers sequentially. His pupil John Northcote gives an account of a work by Parmigianino '[...] which [Reynolds] rubbed and scoured down to the very panel on which it had been painted, so that at last nothing remained of the picture.'¹² Reynolds himself admitted to Abraham Hume (1749–1838) that he had ruined a Watteau while trying to get to the core of his painting technique.¹³ He routinely cleaned and restored old masters including works by Poussin, Rubens, Van Dyck, Titian, Reni and Velázquez. In some cases his 'restorations' might have been justified,¹⁴ but in others, which he completely 'repaired', it is likely that virtually nothing at all remained of the original paintings. In his memoirs, Northcote observed: 'It was a particular pleasure to Sir Joshua when he got into his hands any damaged pictures by some eminent Old Masters; and he very frequently worked upon them with great advantage, and has often made them, both in effect and colour, vastly superior to what they had ever been in their original state.'¹⁵

Reynolds corrects Rembrandt

It was no secret to Reynolds's contemporaries that he restored or reworked paintings of his first-class collection to create 'almost a perfect work.'¹⁶ as exemplified by a pastoral landscape by Claude Lorrain which was in his possession. At the auction of his collection in 1795, two contemporaries noted the presence of considerable overpainting,¹⁷ and on the third day the *Morning Chronicle* reported that 'many of the ... Pictures bear evident marks of having been touched.'¹⁸



Figure 4 Rembrandt, *Susanna and the Elders* (Fig. 1): detail of the area of the palace garden. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Christoph Schmidt.

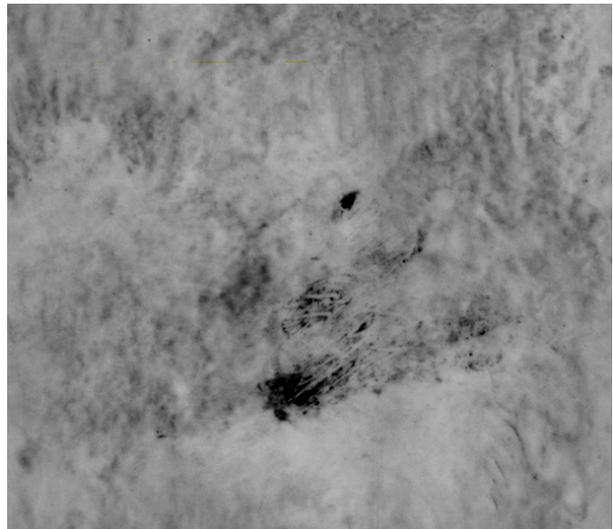


Figure 5 Rembrandt, *Susanna and the Elders* (Fig. 1): detail of the area of the palace garden of the 5th neutron autoradiography. The distribution of the antimony isotope SB-124 appears black. The pigment Naples yellow contains antimony which came increasingly into use from the middle of the eighteenth century onwards. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.

During our examinations – and after additional assessment by colleagues from the Wallace Collection, Reynolds Research Project in front of the original¹⁹ – it quickly became clear that the Berlin *Susanna and the Elders* had undergone revisions by Reynolds's hand. It also became apparent that not only had he eradicated the abovementioned details recorded in the mezzotint, but he had made quite considerable additional interventions in the work (Fig. 6). In some sections, before



Original paint layer abraded, without overpainting



Original paint layer completely removed, repainted



Original paint layer thinned, repainted



Original paint layer nearly untouched, yellowish-brown glaze

Figure 6 Revisions in *Susanna and the Elders* carried out by Reynolds. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.

overpainting them, he wiped off entire areas using liquid solvents, thereby completely removing Rembrandt's original paint layers, while in others he simply thinned down the paint layers. In a number of smaller sections, he only removed the upper paint layers in order to investigate the build-up of the painting. His presumably liberal use of liquid solvents is still visible today in the form of drip marks.²⁰ Finally, he applied a thin greenish-brown paint over large areas of the painting, thus transforming its original rather cool tones.

In total, a large spectrum of 'corrections' by Reynolds can be found,²¹ ranging from fundamental changes – such as in the palace garden, where entire areas were obliterated and recreated – to his own subtly placed accents on Susanna's red slippers. The way Reynolds proceeded suggests that he assumed Rembrandt worked very spontaneously and quickly and it is obvious that he attempted to copy this way of working in the areas he overpainted. He even added scratches into the wet paint in emulation of one of Rembrandt's painting techniques (see Fig. 4). In actuality, Rembrandt's painting technique in *Susanna and the Elders* can in fact be characterised as carefully composed and very precise, unlike Reynolds's cursory and erratic paint application.

Reynolds creates Rembrandt anew

In contrast to *Susanna and the Elders*, technical examination of *Daniel's Vision* has shown that virtually nothing is left of the original, a circumstance described in 1860 as 'a sort of murder'.²² The full extent of the alterations to the picture is recorded in the RKD Rembrandt Database.²³ The original paint layers were



Figure 7 Willem Drost (attributed to), *Daniel's Vision* (Fig. 2) stereoscopic image: detail of the goat's back. The red ground preparation and fibres of the canvas are visible between layers of paint applied by Reynolds. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.

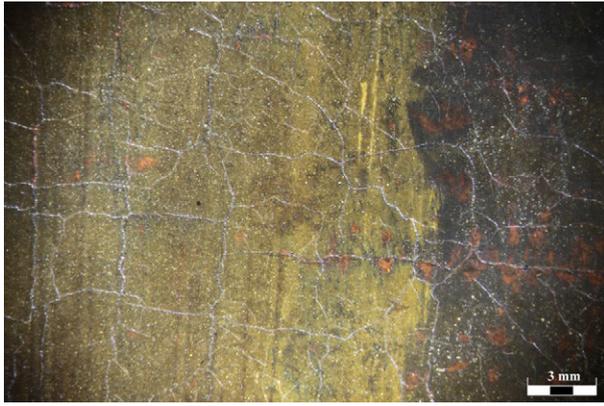


Figure 8 Willem Drost (attributed to), *Daniel's Vision* (Fig. 2) stereoscopic image: right background, detail of the castle. Yellowish-brown paint quickly applied with long vertical brushstrokes. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.



Figure 10 Rembrandt, *Susanna and the Elders* (Fig. 1) stereoscopic image: detail of a plant on the edge of the rock painted by Reynolds. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.



Figure 9 Rembrandt, *Susanna and the Elders* (Fig. 1) stereoscopic image: detail of the palace tower. Cursors long brushstrokes with coarsely pigmented yellow-brown colour. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.

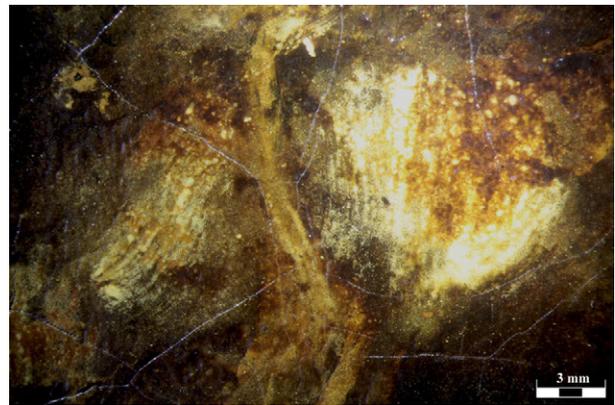


Figure 11 Willem Drost (attributed to), *Daniel's Vision* (Fig. 2) stereoscopic image: detail of a plant in the foreground. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.

completely removed down to the priming (in some cases even to the canvas itself), after which an entirely new work was created on the original canvas.²⁴ During this destructive procedure, the original priming on the canvas was left exposed in many places without giving it a modelling function (Fig. 7).

Detailed comparison to *Susanna and the Elders* provides evidence that the revisions in *Daniel's Vision* also very likely stem from Reynolds's own hand.²⁵ As in the *Susanna* painting, there is evidence of the use of certain pigments that most likely date from the eighteenth century.²⁶ The last autoradiograph of the left edge of the angel's sash shows darkening in the shape of a vertical brushstroke, painted with a yellow containing antimony.



Figure 12 Willem Drost (attributed to), *Daniel's Vision* (Fig. 2) stereoscopic image: the shrinkage of the paint surface suggests that Reynolds used either copaiba balsam or asphalt in this mixture. Photo © Staatliche Museen zu Berlin, Gemäldegalerie/Claudia Laurenze-Landsberg.



Figure 13 Rembrandt School, *Daniel's Vision*, c.1650–52, pen and brown ink, brown wash, corrections in white, 16.5 × 24.3 cm, Paris, Musée du Louvre, inv. no. RF 4715. Photo © RMN-Grand Palais (Musée du Louvre)/Jean-Gilles Berizzi.

The background colour presumably also contains yellow lead antimonate (so-called Naples yellow). In addition, Reynolds's characteristic cursory, long brushstrokes in coarsely pigmented yellow-brown paint can be observed (Figs 8 and 9). A comparable painting technique in both pictures can also be found in the plants. In *Susanna and the Elders*, Reynolds depicted the foliage by the edge of the rock through shapes that were applied clumsily with a wide brush and are clearly distinct from the finely differentiated leaves painted by Rembrandt (Fig. 10). This coarse design and technique is comparable to the plants in *Daniel's Vision*, which were merely indicated by randomly placed brushstrokes without any real structure to define their shapes (Fig. 11). The appearance of the partially swollen, bark-like paint layers (Fig. 12) also suggests that the binding media in this case may have contained additions of copaiba balsam or non-drying asphaltum – a *modus operandi* that has been confirmed in Reynolds's practice in several paintings.²⁷

The fact that in *Daniel's Vision* the original paint layers were almost entirely removed poses fundamental problems for us today: what did the

painting originally look like and who executed it? What was its condition? And why was it completely painted anew? Unlike Rembrandt's *Susanna and the Elders*, no reproduction of the original composition has come down to us. In addition, we only have rather meagre information on its provenance before it entered Joshua Reynolds's collection.²⁸ Nevertheless, certain statements can be made about the painting.

A drawing of *Daniel's Vision* attributed to the Rembrandt School in Paris (Musée du Louvre) shows the exact same composition as the Berlin painting (Fig. 13).²⁹ It is dated to c.1650–52 and may have been made as a type of joint practice assignment or a form of copy in Rembrandt's workshop.³⁰ An exact comparison of the Paris drawing and the Berlin painting shows that both depictions are closely similar down to the level of fine details. Consequently, it may be assumed that the Paris drawing is a copy after a painting, probably the original version of the Berlin painting.

Within this context another remarkable observation can be made: on the drawing, the ram at the



Figure 14 Constantijn Daniel van Renesse with corrections by Rembrandt, *The Annunciation*, c.1652, pen and brush in brown over black and red chalk, white highlights, drawn over with a reed pen in dark brown, 17.4 × 23.1 cm, Berlin, Kupferstichkabinett, Staatliche Museen zu Berlin. Photo © Staatliche Museen zu Berlin, Kupferstichkabinett/Jörg P. Anders.

right edge of the image can be seen in its entirety. In contrast, on the painting the animal's hindquarters are not depicted. As confirmed by our technical report on the painting, the painting was cut precisely at this point. It may therefore be reasonably assumed that the painted depiction of the ram originally corresponded with the drawing, showing the entire animal. In view of the strong correlation between the Paris drawing and the Berlin painting it is likely that the original painting served as a direct source for the drawing. This leads us to the assumption that the Berlin painting was executed in the early 1650s in Rembrandt's workshop, possibly even by the master himself. Thus, Reynolds presumably had an original work from Rembrandt's workshop, which he first removed down to the priming in order to recreate it.

Just how faithfully Reynolds followed the original depiction can also be deduced from the alterations the artist himself made to his version. For example,

a rectangular area visible in the X-ray image was set out in light colours, yet not worked out any further. In the corresponding section in the Paris drawing, the fortification of Susa (or Shushan) is visible. In the Berlin painting, it was ultimately positioned higher, implying that Reynolds initially planned this architectural element in the original location but subsequently preferred a modified pictorial solution. This is also true of the left wing of the angel, which at first still had a wider shape and thus would have corresponded to the manner in which it was depicted in both the original and the Paris drawing. However, Reynolds opted for a more slender design in his finished work. A similar correction can also be found in the ram: initially the legs were set close to one another and left uncovered by the background colour before Reynolds, in a later change, depicted the left foreleg extending backwards. In this case, the first version of the legs also corresponded to that of the original painting and

therefore the drawing. These observations allow us to conclude that Reynolds in his reworking initially adhered faithfully to the composition of the original but subsequently made intentional alterations to the painting to produce its final state.

In two cases Reynolds changed not only the position of motifs, but also their design in detail. One example concerns the fortification mentioned above, which (according to the drawing) originally probably consisted of a structure with walls and a rectangular tower. Reynolds modified this feature by inserting in its place a rather stately building with a semicircular tower and high arched windows. Interestingly, the modified architecture is reminiscent of the palatial structure depicted in the Berlin *Susanna and the Elders*. It is more than likely that Reynolds also substantially changed the figure of the angel. According to the Paris drawing, the figure initially had a tuft of curly hair and a fairly broad face. On the version by Reynolds, however, the angel has long blond flowing hair and delicate and charming facial features, a depiction that may have originated in the drawing of the *Annunciation* made by Constantijn Daniel van Renesse and corrected by Rembrandt (Fig. 14). This drawing, also part of Reynolds's collection, depicts an angel with a very similar, doll-like physiognomy and long blond hair.³¹ It is widely known that Reynolds used his art collection as a source of inspiration for his own work.³² He probably resorted to his extensive collection for the alterations described here as well, and used 'original examples' from Rembrandt's workshop.

Possible motivations for the revisions made by Reynolds

In all probability, the revisions to *Susanna and the Elders* were not motivated by necessity because the condition of the painting, despite its alterations, can even now be described as very good. Reynolds's interventions would therefore not have been repairs or restorations. In the case of *Daniel's Vision*, we can now only speculate as to its condition in the eighteenth century, but in both cases the question arises as to why Reynolds chose to carry out such substantial interventions.

Reynolds, who owned 27 paintings and 49 drawings by the master and his workshop, may be

counted as one of the greatest Rembrandt collectors and connoisseurs of his time.³³ Despite this clear predilection for the master, Reynolds's relationship to Rembrandt was quite ambivalent: there does not seem to be any other artist whose impact on Reynolds was both so inspiring and so disturbing. He must have really struggled to attain Rembrandt's technical and aesthetic qualities, and the preoccupation with his work would probably have resulted in great insecurity and contradictory responses.³⁴ Reynolds acknowledged the master's extraordinary genius, yet seemed to be worried by his breaches of decorum. Since Rembrandt was not a good example of the 'grand manner' advocated by Reynolds, most of the remarks about the Dutch artist he made to his pupils were a critique of his lack of dignity. In his travel notes on the Rembrandt version of *Susanna and the Elders* in The Hague (Mauritshuis), he arrives at the damning verdict: 'so very ugly and ill-favoured a figure'.³⁵ Rembrandt, according to Reynolds's pupil John Northcote, 'took her [nature] without selection, and without exactness. It is true we see nature in his figures, but we are sorry to say it is nature'.³⁶ Despite much admiration, in his opinion there was still room for improvement in Rembrandt's work.

In eighteenth-century Britain, Rembrandt was one of the most prized and expensive Dutch old masters.³⁷ His growing popularity led to an inflationary number of so-called 'Rembrandt works' turning up at auctions. Any kind of 'dark' painting was quickly classified as a Rembrandt, pushing his actual style and artistic development into the background.³⁸ Within this context it is understandable that those living in the eighteenth century were unable to appreciate either Rembrandt's early or late work: the former was felt too segmented and austere, the latter too diffuse and coarse. Reynolds's intention may therefore have been to render the two paintings under discussion more 'Rembrandtesque' as it was understood in his time. This context also serves to explain why Reynolds's interventions in *Susanna and the Elders* mainly concern those areas Rembrandt had executed in detail, which Reynolds casually painted over and the more precise contours of which he dissolved, and why he darkened the painting – which was originally much lighter and more colourful – and applied a yellowish layer over it. *Daniel's Vision*

was similarly provided with a dark overall finish, since Reynolds applied a brownish glazing over large parts of the painting. The painting technique in this case is also characterised by cursory and rapid suggestive brushwork without any real definition.

At the same time, alterations in both paintings provide evidence of Reynolds's desire to transform their lower and rather more earthy character, into loftier and more graceful representations. Thus the expressive face of the elder to the rear in the *Susanna* painting, to whom Rembrandt had originally given repellent lecherous features, was reworked by Reynolds, neutralising his expression. Instead of a clearly open-toothed mouth, we now find an irresolute depiction of a thin-lipped, smug smile.³⁹ In *Daniel's Vision*, Reynolds changed the appearance of the angel by giving it attractive features, which would have been most untypical of Rembrandt. In this case it seems as if Reynolds, by any means, was seeking to 'improve' the painting in the eighteenth-century sense, since those areas which were later to cause criticism and cast doubts on its authenticity, such as the depiction of the angel, met with great approval in particular.⁴⁰ The revisions should therefore be understood as intended improvements to both works.⁴¹

Conclusions

The question remains as to why Reynolds painted *Daniel's Vision* entirely anew from the very priming and did not, as in *Susanna and the Elders*, merely revise certain parts. Unfortunately, we have no information on the exact date when the painting became part of Reynolds's collection, who previous owned it and what kind of condition it was in. It may have been a damaged painting 'worth nothing [...] but to a Painter', as Reynolds himself categorised these kinds of paintings.⁴² Perhaps he considered it expedient – as he had in comparable cases⁴³ – to fundamentally rework and thus resurrect the painting to its original splendour. What can now be ruled out is an inadvertent destruction of the painting due to over-cleaning or an attempt at understanding the painting technique. We have established that Reynolds was faithful in his reconstruction of

the painting's original composition to a considerable degree. Based on this precise correspondence, it may therefore be reasonable to assume that he first created some kind of copy or prototype before removing the original paint layers, and that he started work very well prepared.

Notes and references

1. Rembrandt, *Susanna and the Elders*, 1647, oil on wood (*Peltogyne venosa/Peltogyne* spp.), 76.6 × 92.7 cm, Gemäldegalerie, Staatliche Museen zu Berlin, inv. no. 828 E. According to current research almost completely reworked by J. Reynolds, *Daniel's Vision*, oil on canvas, 99 × 119 cm, Gemäldegalerie, Staatliche Museen zu Berlin, inv. no. 828 F.
2. Rosenberg, A. (1883), 'Neue Erwerbungen der Berliner Gemäldegalerie', *Kunstchronik* 18: col. 473–477, col. 474 ('Sie sind ... ebensosehr von jeder Beschädigung wie von jeder fremden Hand verschont geblieben').
3. The examinations took place within the research project 'Rembrandt Autoradiography / The Rembrandt Database: Neue Forschungen zu den Rembrandt-Beständen der Gemäldegalerie Berlin'. Project duration: 2011–2016. Research members: Dr Katja Kleinert and Claudia Laurenze-Landsberg. Funded by the Andrew W. Mellon Foundation, the Staatliche Museen zu Berlin, and the Helmholtz-Zentrum Berlin für Materialien und Energie GmbH.
4. *Ralph's Exhibition of Pictures*, Haymarket, London, 1791 (Great Room no. 48).
5. In 1957/58, the first doubts regarding its attribution were raised by Werner Sumowski, who considered the painting to be the work of a pupil (perhaps C. Fabritius) after one of Rembrandt's drawings: see Sumowski, W. (1957/58), 'Nachträge zum Rembrandtjahr 1956', *Wissenschaftliche Zeitschrift der Humboldt-Universität zu Berlin. Gesellschafts- und sprachwissenschaftliche Reihe* 7: 223–78, pp. 236–8. Subsequently, most authors concurred with the attribution to a Rembrandt pupil or workshop of Rembrandt. In 1984, Joshua Bruyn was the first to attribute the painting to Willem Drost: see Bruyn, J. (1984) 'Review of Sumowski, Gemälde, vol III', *Oud Holland* 98(3): 146–62, pp. 148 and 153. This attribution was widely acknowledged and has thus far been recognised by the Gemäldegalerie as valid. Jonathan Bikker was somewhat more sceptical in his dissertation on Drost's oeuvre and considered such an attribution problematic due to the painting's poor condition: see Bikker, J. (2005)

- Willem Drost: A Rembrandt Pupil in Amsterdam and Venice*, New Haven/London, Yale University Press 2005: 131–3.
6. Reynolds estimated the value of *Daniel's Vision* at 600 guineas as against 350 guineas for *Susanna and the Elders*: see Farington, J. (1978–1984), *The Diary of Joseph Farington*, vol. 1–6 (1978–79), ed. K. Garlick and A. Macintyre, vol. 7–16 (1982–84) ed. K. Cave, New Haven/London, Yale University Press: vol. 2, p. 316.
 7. See White, C., Alexander, D. and D'Oench, E. (1983) *Rembrandt in 18th Century England*, New Haven, Yale Centre for British Art: 18–19; Richard Earlom, *Susanna and the Elders*, 1769, mezzotint, 455 × 535 mm (plate), Kupferstichkabinett, Staatliche Museen zu Berlin, inv. no. 738-32, 739-32 (copy from the Reynolds collection).
 8. Richard Earlom (1743–1822), *Susanna and the Elders*, 1769, mezzotint, 455 × 535 mm. Inscribed: *Rembrandt pinxit*, rechts: *R. Earlom fecit* in der Mitte: *John Boydell excudit, 1769*. Darunter die Inschrift: *SVSANNA AND THE ELDERS. From the Original Picture Painted by Rembrandt in the Collection of S.^r Jos.^a Reynolds. Size of the Picture F. 9 25 ½ by 30 in Length / Publish'd June 12, 1769 by J. Boydell, Engraver in Cheapside London*. Kupferstichkabinett, Staatliche Museen zu Berlin.
 9. In the last autoradiograph, the yellow treetop below the right wing of the palace tower partially exhibits a deep darkening due to the antimony isotope Sb-124. A point XRF analysis of the area with the strong darkening using an ARTAX spectrometer confirmed the presence of antimony and copper. No tin was detected. The light yellow pigment is therefore Naples yellow, confirming the suspicion that the painting of the garden originates from the eighteenth century. Naples yellow is a lead antimonate, which was used increasingly from the middle of the eighteenth century.
 10. See Bevers, H., Kleinert, K. and Laurenze-Landsberg, C. (2015), *Rembrandts Berliner Susanna und die beiden Alten. Die Schaffung eines Meisterwerks*, exh. cat., Kupferstichkabinett und Gemäldegalerie Staatliche Museen zu Berlin: 63, 89–92.
 11. See Kirby Talley, M. (1986), “All good Pictures Crack”: Sir Joshua Reynolds's practice and studio, *Reynolds*, exh. cat., London, Royal Academy of Arts: 55–70; Gent, A., Roy, A. and Morrison, R. (2014), ‘Practice makes imperfect: Reynolds's painting technique’, *National Gallery Technical Bulletin* 35: 12–31.
 12. Northcote, J. (1818) *The Life of Sir Joshua Reynolds*, 2 vols, London: vol. 2, p. 22.
 13. Kirby Talley 1986 (cited in note 11) 56.
 14. Broun, F. (1993) *Sir Joshua Reynolds' Collection of Paintings*, PhD thesis, Princeton University, NJ, 3 vols: vol. 1, p. 51. [Photocopy. Ann Arbor, MI. University Microfilms International, 1987.]
 15. Northcote, J. (1815) *Memoirs of Sir Joshua Reynolds*, London [Supplement]: 134.
 16. Northcote 1818 (cited in note 12) vol. 2, p. 14.
 17. In his auction catalogue, Sir Abraham Hume, a friend of Reynolds, remarked on the painting: ‘Been painted over by Sir J. Reynolds whose it was and spoilt. Captain Bailie and Mr. Cox [say] Sir Joshua never knew when to stop his brush!’. See McIntyre, I. (2003) *Joshua Reynolds: The Life and Times of the First President of the Royal Academy*, London, Allen Lane: 181.
 18. Broun 1993 (cited in note 14) vol. 2, p. 194.
 19. With thanks to Lucy Davis and Alexandra Gent, Wallace Collection, Reynolds Research Project. See Roy, A. (ed.) (2014) ‘Joshua Reynolds in the National Gallery and Wallace Collection’, *National Gallery Technical Bulletin* 35 (special edition).
 20. Bevers *et al.* 2015 (cited in note 10) 66, fig. 7.
 21. For more detail see Bevers *et al.* 2015 (cited in note 10) 61–73.
 22. ‘The willful destruction of a work of a genius is a sort of murder, committed for the sake of art; and the propriety of the act is very questionable’: Cunningham, A. (1860) *The Life and Writings of Sir Joshua Reynolds, First President of Royal Academy*, New York: 54.
 23. For more detail, compare also the technical reports on the painting in the Rembrandt Database: <http://rembrandtdatabase.org/>.
 24. Cusping is discernible along all four edges, indicating that the painting was mounted traditionally before being primed and worked on further. As Reynolds, by contrast, often used pre-primed canvases, which were presumably cut from larger pieces and therefore rarely exhibit cusping, it is unlikely that the canvas and priming are by his hand. See Gent *et al.* 2014 (cited in note 11) 16.
 25. See Bevers *et al.* 2015 (cited in note 10) 61–72.
 26. See note 8.
 27. Kirby Talley 1986 (cited in note 11) 63–4.
 28. The painting was probably auctioned in 1715 in London. Auction Mr. Motteux's Auction Room in the Little Piazza in Covent Garden, London circa 1715, no. 41 (‘Rembrandt. Daniel's Vision of the Ram’). *Motteux's Sale of Pictures, circa 1714–17; transcript of printed auction catalogues in the so-called Houlditch manuscript, vol. 2, p. 36, middle of the 18th century, National Art Library, pressmark 86.00.18*.
 29. Rembrandt School, *Daniel's Vision*, pen and brown ink, brown wash, corrections in white, 16.5 × 24.3 cm, Paris, Musée du Louvre, inv. no. RF 4715: Benesch, O. (1973) *The Drawings of Rembrandt*, catalogue raisonné, rev. E. Benesch, 2nd edn, 6 vols, London 1973: no. 901 (as a sketch by Rembrandt for the Berlin painting); *Rembrandt et son école, dessin du Musée*

- du Louvre*, exh. cat., Paris, Musée du Louvre, 1988/89: cat. no. 55. Schatborn does not include this drawing in the Rembrandt inventory of the Musée du Louvre: Schatborn, P. (2006) *Cabinet des dessins, Rembrandt*, Paris, Harry N. Abrams. Attribution to the Rembrandt School from the period 1650–52 by Holm Bevers: Bevers *et al.* 2015 (cited in note 10).
30. With thanks to Holm Bevers for providing this information. Interestingly, at the beginning of the 1650s the Rembrandt workshop engaged in an intense study of historical depictions with two figures. See *Rembrandt der Meister und seine Werkstatt / De Meester en zijn Werkplaats/The Master and His Workshop*, exh. cat., Altes Museum Berlin/Rijksmuseum Amsterdam/The National Gallery, London) 1991/1992, vol. 1 (paintings), cat. no. 82, p. 387.
31. Constantijn Daniel van Renesse with corrections by Rembrandt, *The Annunciation*, c.1652, pen and brush in brown over black and red chalk, white highlights, drawn over with a reed pen in dark brown, 17.4 × 23.1 cm, Berlin Kupferstichkabinett, Staatliche Museen zu Berlin. Compare Bevers, H. (2006) *Rembrandt. Die Zeichnungen im Berliner Kupferstichkabinett*, Kritischer Katalog, Berlin, cat. no. 47.
32. Gent *et al.* 2014 (cited in note 11) 19.
33. Broun 1993 (cited in note 14), vol. 2, pp. 91–7; White *et al.* 1983 (cited in note 7), 8.
34. Broun 1993 (cited in note 14), vol. 1, pp. 93–4; White *et al.* 1983 (cited in note 7), 12–13.
35. Mount, H. (ed.) (1996) *Sir Joshua Reynolds: A Journey to Flanders and Holland*, Cambridge, Cambridge University Press: 85.
36. Northcote 1818 (cited in note 12), vol. 2, p. 60.
37. White *et al.* 1983 (cited in note 7) 6–9.
38. Broun 1993 (cited in note 14) vol. 2, p. 41.
39. Bevers *et al.* 2015 (cited in note 10) 66–7, figs 14–16.
40. Broun 1993 (cited in note 14) vol. 2, pp. 54–5.
41. To perfect his collection, Reynolds reworked several other paintings by old masters. See Broun 1993 (cited in note 14) vol. 1, p. 50, vol. 2, pp. 39–44 (Rembrandt), pp. 45–7 (Rembrandt), pp. 100–101 (van Dyck), pp. 132–6 (Rubens), pp. 162–3 (Rubens), pp. 192–6 (Lorrain), pp. 328–9 (Veronese), pp. 335–6 (Velázquez). On the Veronese painting, see also Farington 1978–1984 (cited in note 6), vol. 2, p. 318. According to most recent findings, Reynolds also extensively abraded and almost completely reworked the Rembrandt painting *Man with Red Beret* in his possession (Rotterdam, Museum Boijmans Van Beuningen).
42. Hilles, F.W. (ed.) (1929), *The Letters of Sir Joshua Reynolds*, Cambridge, Cambridge University Press: 147.
43. Broun 1993 (cited in note 14) vol. 1, p. 51.

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Using macro-XRF to examine Rembrandt's *Portrait of Frederik Rihel on Horseback*: new insights on pigment distribution and a hidden portrait

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ABSTRACT A new study into the painting materials and history of Rembrandt's *Portrait of Frederik Rihel on Horseback* in the National Gallery, London, has been carried out using macro-X-ray fluorescence scanning (macro-XRF). Past research into the picture had revealed that Frederik Rihel had been painted on top of a different portrait, most easily visible in the X-radiograph. The new study with macro-XRF (an instrument which images the distribution of chemical elements present in a picture) brought to light new features in the hidden portrait, as well as some insights into the pigments used to paint it. In addition, by exploring the macro-XRF results in the context of previous analyses, some new interpretations of Rembrandt's palette and technique for the Rihel portrait have been made.

Introduction

The *Portrait of Frederik Rihel on Horseback* (London, National Gallery, NG6300) (Fig. 1) is Rembrandt's largest known equestrian portrait, at 2.9 × 2.4 m. Shortly after its acquisition by the National Gallery in 1960, an infrared photograph was made and X-radiographs captured of 10 selected areas. The National Gallery's 1988 publication, *Art in the Making*, included observations based on these technical images together with information obtained from a number of microscopic paint samples and presented these alongside the results of technical examination of other Rembrandt paintings.¹ However, it was not until a full X-radiograph of the entire picture was recorded in 2008, when it was re-examined in preparation for the 2014 *Rembrandt: The Late Works* exhibition by Betsy Wieseman (then

curator of Dutch painting 1600–1800), that a hidden portrait underlying the finished composition was revealed (Fig. 2, left). This discovery was described in detail in 2010 in Wieseman's article in volume 31 of the *National Gallery Technical Bulletin*.² Oriented at 90° to the finished portrait (rotating clockwise), the hidden picture shows a single figure in sombre dress, holding a staff. In the X-radiograph his torso, head and face are easily discernible, with his facial features also being reasonably clear. His boots and legs are visible, but there is an illegible, dark shape to his proper left that reaches up to about waist height. A group of trees can be identified by their shadowy trunks to the hidden figure's proper right. Although the X-radiograph does not reveal features relating to the hidden composition across the entire canvas (it does not make visible anything in the area between the hidden figure and the trees, for example), a



Figure 1 Rembrandt, *Portrait of Frederik Rihel on Horseback*, c.1663, oil on canvas, 294.5 × 241 cm, NG6300, The National Gallery, London. Photo © The National Gallery, London.

re-examination of existing cross-sections from locations across the entire painting indicated that all included lower paint layers that appear to relate to the hidden composition. This suggests that paint from the first version extends beneath the entirety of the finished painting, although it is not clear to what degree this hidden composition was completed.

Rembrandt often reused painting supports, but it is thought that this was usually for paintings he made on his own initiative, including a number of his self-portraits for example.³ This overpainting of a picture with a commissioned portrait is thought to be unique in Rembrandt's oeuvre,⁴ perhaps as a practical step to salvage such a large canvas support, which is made up of three pieces of fabric stitched

together.⁵ There was no evidence in cross-sections for a 'blocking-out' layer between the two compositions, nor was there any evidence of dirt, suggesting the artist painted the second composition not long after the first portrait was painted.⁶ There are even some areas where the first composition has not been fully covered by the second, such as in the foreground at the lower left where Rembrandt left some of the first picture exposed.⁷

Since 2008, further analytical work has been carried out, but the good condition of the paint in the area of the hidden man prevented further sampling in this region. Although the sitter has never been identified, in her 2010 article discussing the concealed composition and Rembrandt's reuse of his canvas,



Figure 2 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1): X-radiograph acquired in 2008 (rotated 90° counterclockwise, left); infrared reflectogram acquired in 2014 (rotated 90° counterclockwise, right). Photos © The National Gallery, London.

Wieseman considered the possibility that this over-painted picture was another portrait of Frederik Rihel but executed 10 years earlier. However, it would be unusual for a commissioned portrait to sit in a studio for this length of time, a circumstance that perhaps might have incited legal action from the commissioning patron. Rihel's rise in status over the intervening time period was suggested as an explanation for the repainting of the picture.⁸

The 1960 infrared photograph provides valuable information about the upper portrait of Rihel, but does not show any clear detail from the concealed picture. However, an infrared reflectogram (IRR) was recorded in 2014 (Fig. 2, right), revealing the underdrawing for the current composition and some minor changes made during painting (the clearest being the reduction in size of Rihel's hat) and providing additional detail of the hidden composition: the trees on the hidden man's proper right are just discernible, as are some parts of the concealed man himself – especially his black hat, face and his proper right shoulder. The information obtained by this new IRR was complementary to the X-radiograph, but did not greatly improve the understanding of the hidden composition.

In 2015, through a collaboration with Delft University of Technology, the National Gallery had obtained on loan a Bruker M6 Jetstream macro X-ray fluorescence (macro-XRF) scanner.⁹ This instrument uses X-ray radiation to induce fluorescence and by recording the emitted X-ray fluorescent radiation,

the chemical elements present can be identified and the elemental distributions mapped. When applied to paintings, this technique can enable the identification and visualisation of inorganic pigments across the picture. In some situations, pigments can be detected even when they are covered by other paint layers, enabling the visualisation of overpainted passages: however, the signal from these lower layers can sometimes be blocked by upper paint layers, depending on the density and shielding power of the pigments therein. The data acquired complements that from well-established sample-based and technical imaging methods to give information about the condition, use of materials and any *pentimenti* in a painting.¹⁰

The use of a macro-XRF scanner presented a significant opportunity to better understand the materials in the *Portrait of Frederik Rihel on Horseback* and to understand more about the hidden composition. Rembrandt's works are particularly well represented among those paintings that have been investigated using macro-XRF, and there is a considerable body of publications presenting the results, including investigations of his reuse of painted supports.¹¹ Due to the large size of the painting, and the limited period of the instrument loan, it was not possible to scan the entire picture. It was thought that exploring the area where the X-radiograph had revealed the hidden man would be of greatest benefit, especially as there were few cross-sections from this area. Nine scans were undertaken in this area and joined.¹²



Figure 3 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail: copper distribution map, rotated 90° counter-clockwise and brightness-adjusted. Photo © The National Gallery, London.



Figure 4 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail: mercury distribution map, rotated 90° counter-clockwise. Photo © The National Gallery, London.

The underlying portrait

The figure in the hidden composition is evident in the copper, mercury and lead XRF maps (Figs 3–5, overlay in Fig. 6). The copper and mercury maps reveal his silhouette, showing that the landscape was carefully painted in around the figure (or a reserve was left), so that the features of his clothes and his posture are clearly visible in outline. This reveals that the figure was sketched out or painted before the background was added around him. Wieseman had already remarked, on the basis of the 2008 study of the X-radiograph, that the ‘broad undulating contours appearing light and dark in the X-radiograph extend from the left side of the composition suggesting a landscape setting.’¹³ The copper XRF map (Fig. 3) shows the clearest outline of the figure, with

copper being detected in the sky and landscape behind him, suggesting the use of copper-based pigments possibly to make blue or green passages, as are typical of Rembrandt landscapes.¹⁴ There is also some copper visible in the hidden figure’s body and legs, which may indicate the presence of copper-based pigments in the modelling of the folds of his boots, trousers and jacket, details that were not visible in the X-radiograph. However, it is also possible (assuming that this does not relate to the surface painting) it is associated with a copper-containing layer below that is being partially shielded by intervening layers, or it could indicate the use of a copper-based material as a drier (verdigris, for example, was often used for this purpose in black paints).¹⁵ Previous analysis of a cross-section from an area of background at the bottom left of the picture

(corresponding to an area to the bottom right of the hidden composition) identified a paint layer beneath the surface paint containing azurite along with smalt, red lake and earth pigments.¹⁶ Comparison of this cross-section with the copper XRF map suggests that much of the background around the hidden figure is painted with mixtures of this kind, containing azurite (and/or other copper-based blue or green pigments), employed in a variety of tones across the landscape.¹⁷

Features in the hidden composition give rise to an intense signal in the mercury XRF map (Fig. 4). This indicates the use of vermilion, a vivid red pigment which had not previously been identified anywhere on this painting. In the mercury XRF map, a broad band of vermilion-containing paint can be seen, applied around the figure's legs (and outlining the lower part of his boots), suggesting a long, flat but irregular feature behind him. This might relate to the landscape as it appears to sit just below the regions yielding intense copper signals associated with the sky and landscape, although it seems too low in the hidden composition to suggest a sunset or horizon. However, it could equally suggest a log or fallen tree, as brown colours were often achieved by artists at this time by combining vermilion and black.¹⁸

The lead XRF map is particularly useful for visualising hidden paint layers for two reasons: the first is the strength and relatively high energy of the lead fluorescence, which enables clear visualisation of hidden lead-containing paint layers. The second is the multiplicity of energy lines at which lead fluoresces. This means that the lead XRF map can be manipulated by subtracting the low energy map (corresponding to the M-line series of X-rays, which do not penetrate far through the paint and mainly relate to the surface composition) from the high energy map (corresponding to the L-line series of X-rays, which have deeper penetration). The lead XRF map resulting from subtraction of the lead M-line map from the lead L-line map (Fig. 5) revealed the hidden composition with increased clarity, especially when combined with the copper and mercury XRF maps, which help define his outline (Fig. 6). While Wieseman was able to discern many significant details from the X-radiograph, some new features are clearer in the overlaid XRF maps. The hidden man is standing with his feet slightly apart, wearing boots with a folded top. He wears a large

coat or jerkin, and at his neck a collar can be seen (likely to be light-coloured as it is rich in lead-based pigments) with what appears to be detailing or shadows added with a copper-containing paint, and he has one arm bent as if on his hip (or possibly holding something indistinct in front of his body). There is a thin, vertical shape in the lead XRF map that contains less lead than the surrounding areas and which looks somewhat like a staff (held in the figure's proper right hand). This feature is visible in the iron XRF map, suggesting it was painted using earth pigments (Fig. 8, left). The lead XRF map indicates a triangular shape on his proper right shoulder and features down the front of the coat or jerkin, suggesting detailing in or on the fabric or decoration along the edges of the garment.

The hidden sitter's identity has been of great interest since his face was first seen in the X-radiograph,¹⁹ and although it would be unwise to draw firm conclusions about the identity of the hidden figure based on these technical images, the lead map seems to reveal his facial features with more clarity as can be seen in the detail in Figure 7 (right). He appears to have a square jaw, with a broad nose, characteristics that seem to contrast with those of Frederik Rihel (Fig. 7, left), whose jaw is softer, with a more rounded chin and straight nose. The eyes of the first sitter are very clear in the lead map, but they do not seem to be the same round, hooded eyes with the arched eyebrows as seen for Rihel. The hidden figure is similar, but he does not seem to greatly resemble Frederik Rihel as he is depicted in the final composition.

In the X-radiograph, in the dark area to the proper left hand side of the hidden figure, 'a distinct but unidentifiable motif in light radioabsorbent paint' had previously been described.²⁰ However, new evidence provided by the copper, mercury and lead XRF maps reveal this area to contain a dog. This animal is most clearly visualised via the 'reserve' in the copper map (Fig. 3), but the overlay of the copper, mercury and lead XRF maps (in Fig. 6) lends a new clarity to this figure. As was the case with the hidden man, either a reserve was left in the landscape paint or the dog was painted (or at least sketched in) before the landscape was painted in around it, as the mercury and copper XRF maps clearly show (Figs 3 and 4). They reveal a mid-sized dog (about waist high to the man), with long legs (all four are visible in the overlaid image) and a thin, curving tail. The lead map (Fig. 5)



Figure 5 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail: lead distribution map (the lead L-line map with the map from the lead M-line subtracted), rotated 90° counterclockwise. Photo © The National Gallery, London.



Figure 6 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail: RGB composite image from the distribution maps of copper (green), mercury (blue) and lead (lead L-line map with the map from the lead M-line subtracted, red), rotated 90° counterclockwise. Photo © The National Gallery, London.



Figure 7 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1): detail of Frederik Rihel's face in the final image, visible light (left); detail of the hidden figure in the first composition as shown in the X-radiograph (centre) and in the lead XRF map (lead L-line map with the map from the lead-M line subtracted, right). Photos © The National Gallery, London.

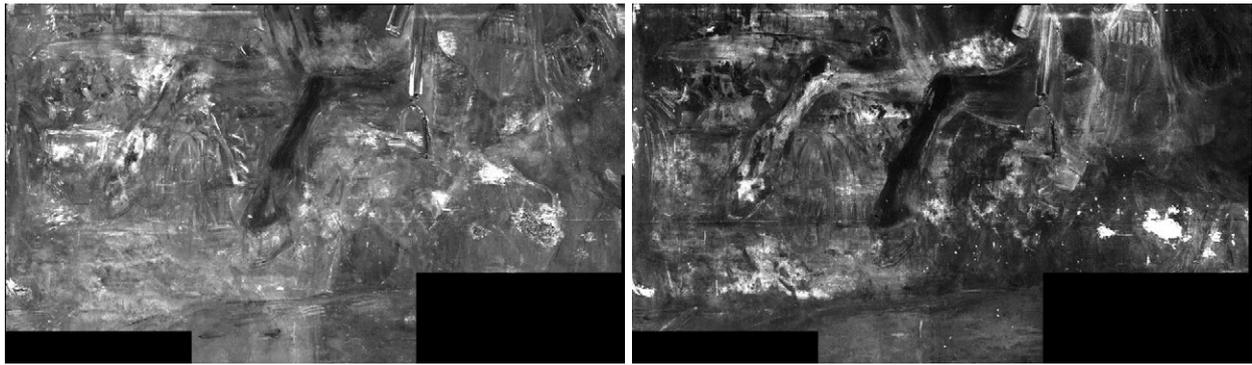


Figure 8 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail of the area with the horse's front legs and the carriage in the background: distribution maps for iron (left) and calcium (right). Photos © The National Gallery, London.

suggests careful detailing of the musculature and highlights on the paws – these were probably painted in lead white. The dog's height and shape, as well as its long legs, suggest that it was some kind of hunting breed. Unfortunately, the area of the head is illegible in all the elemental maps, as it is blocked by the hoof of Frederik Rihel's horse, which lies directly on top. Furthermore, there is a strange, circular shape in the area of the animal's neck in the lead map (just below where the head should be) which does not appear to relate to the final composition and while not easily understood in the context of the hidden composition might relate to a collar around the dog's neck.²¹

Only a small region of the whole painting was scanned and therefore no further information has been gained about the hidden portrait in the region to the proper right of the figure. It must be assumed that something was intended to be depicted given that the standing man is positioned slightly to the right of the centre of the painting; macro-XRF scanning of the rest of the painting in the future would hopefully provide greater insight into the rest of the first composition.²²

Materials and technique: new findings and perspectives

As well as providing new insight into the underlying portrait, the use of macro-XRF has given a new perspective on Rembrandt's palette, revealing the distribution of pigments, complementing the cross-section evidence and providing pigment information in areas that were not (and could not be) sampled. The lead XRF map (Fig. 5) mainly reflects the distribution of lead white, especially in the upper composition,

with particularly intense signals in the highlights on the white horse (in addition to the areas of the hidden portrait as described in the section above). The iron XRF map (Fig. 8, right) correlates closely with the compositional elements of the finished picture since much of the final picture is painted with mixtures rich in earths and ochres. The cross-sections confirm yellow earths in the yellow tassels, for example, and red earth in the red of the stirrup straps. The iron XRF map also reveals iron-containing pigments in the area of the carriage. It is worth noting that the signal from earth pigments in the hidden portrait would not necessarily be expected to be detected through the overlying paint layers and indeed the only iron signal that is clearly visible from the hidden picture (and distinct from the upper composition) is the man's tall, slender staff, which can be seen in the iron and calcium XRF maps as a thin line (running horizontally through the chest of the horse), suggesting the use of earth pigments to paint this feature (Fig. 8). The manganese XRF map did not show much signal relating to this element, suggesting that there is no detectable umber pigment in the upper layers of the Rihel portrait (although it is possible there may be some present in the lower paint layers but that the manganese fluorescence signal is blocked by overlying paint).²³

The IRR (Fig. 2) shows that Rihel's hat as finally painted covers an earlier, taller hat, suggesting that both were painted using a carbon-containing black pigment. While IRR cannot differentiate between different types of carbon-containing black pigments, the calcium XRF map appears to show a correlation to some of the dark passages (the hidden figure's proper right shoulder and a portion of the man's hat for example, see Fig. 8), suggesting that ivory or bone black could have been used to darken the paint in

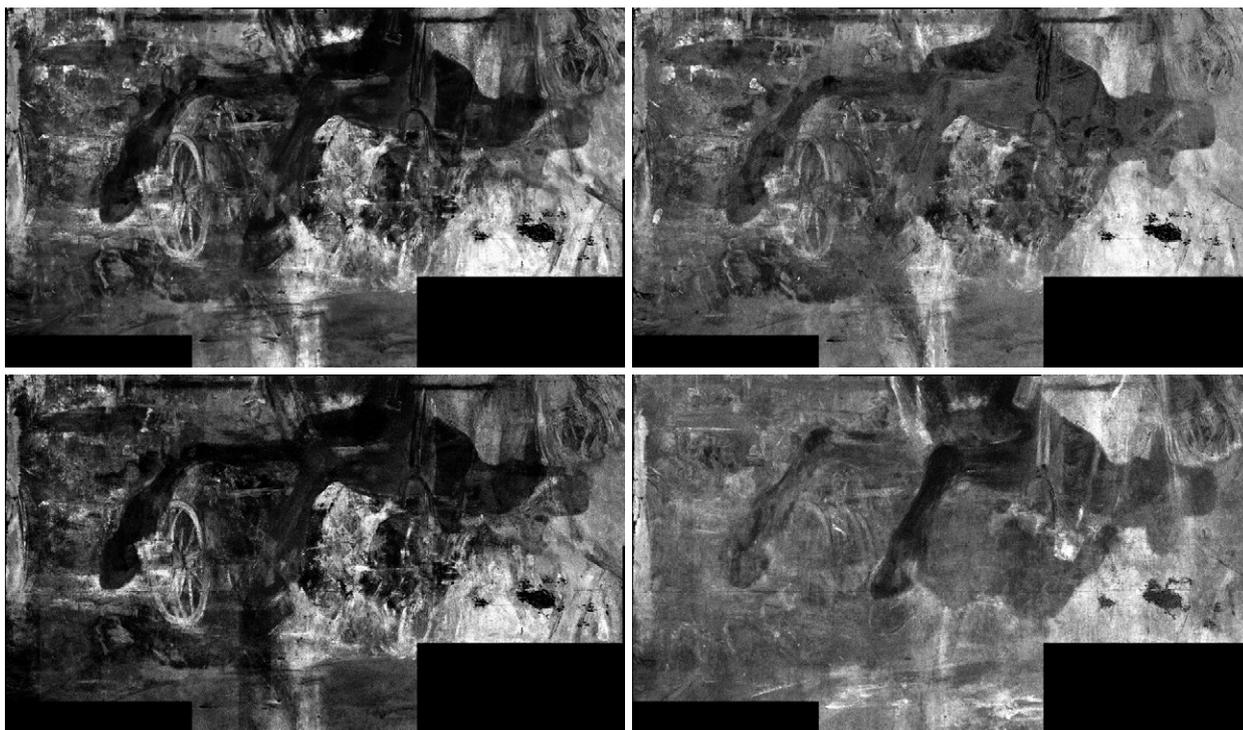


Figure 9 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1), detail of the area with the horse's front legs and the carriage in the background: distribution maps of elements associated with the pigment smalt: cobalt (*top left*), arsenic (*top right*), nickel (*bottom left*) and potassium (*bottom right*). Photos © The National Gallery, London.

these areas. The presence of both phosphorous and calcium in black passages would typically be used to confirm the use of these pigments, although in this case the low energy phosphorous fluorescence signal would not be expected to be observed from lower paint layers.²⁴

Vermilion had not been identified anywhere on this picture prior to the macro-XRF scanning. Rembrandt was known to use vermilion, but sparingly; he generally preferred to create vibrant reds by combining earth pigments with red lake pigments.²⁵ A cross-section from the red stirrup strap in this painting confirmed the use of this type of mixture. However, the mercury XRF map (Fig. 4) for *Frederik Rihel* suggests the occasional use of vermilion for bright red patches, as well as for some more subtle effects. As discussed in the section above, some mercury was found in the hidden composition (in the scenery behind the man and dog), but it was also found in details of the upper Frederik Rihel portrait: in his scabbard, shading of the horse's hoof, as well as in some of the figures in the carriage. It was also identified in the highlights of the stirrup straps. No vermilion was detected in the cross-section from this area but the sample may not have included any of this pigment as it was located solely in the

highlight. There are two mercury-containing dots to the left of the horse's left knee: it is not clear to what features they relate, nor whether they are part of the final or hidden composition. Rembrandt was known to have used vermilion to give rosy tones to his flesh paint,²⁶ however no mercury was detected in the face of the hidden sitter (and the face of Rihel himself was not in the area scanned).

Rembrandt is well known for using smalt throughout most of his career.²⁷ Smalt is a blue pigment made of cobalt-containing glass, which was sometimes used for its drying and bulking properties as well as for its colour. However, it has a tendency to degrade and discolour over time when painted in oil.²⁸ The potassium leaches out of the potash glass, discolouring the oil around it, and changing the environment of the cobalt so that the pigment loses its blue colour. The large amount of smalt found in the cross-sections in *Frederik Rihel* indicates that Rembrandt used this pigment in many areas, in both the upper and lower compositions on this canvas. Quantitative scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX) of the cross-sections indicates that there is a difference in the chemical composition of the smalt used in the Rihel portrait

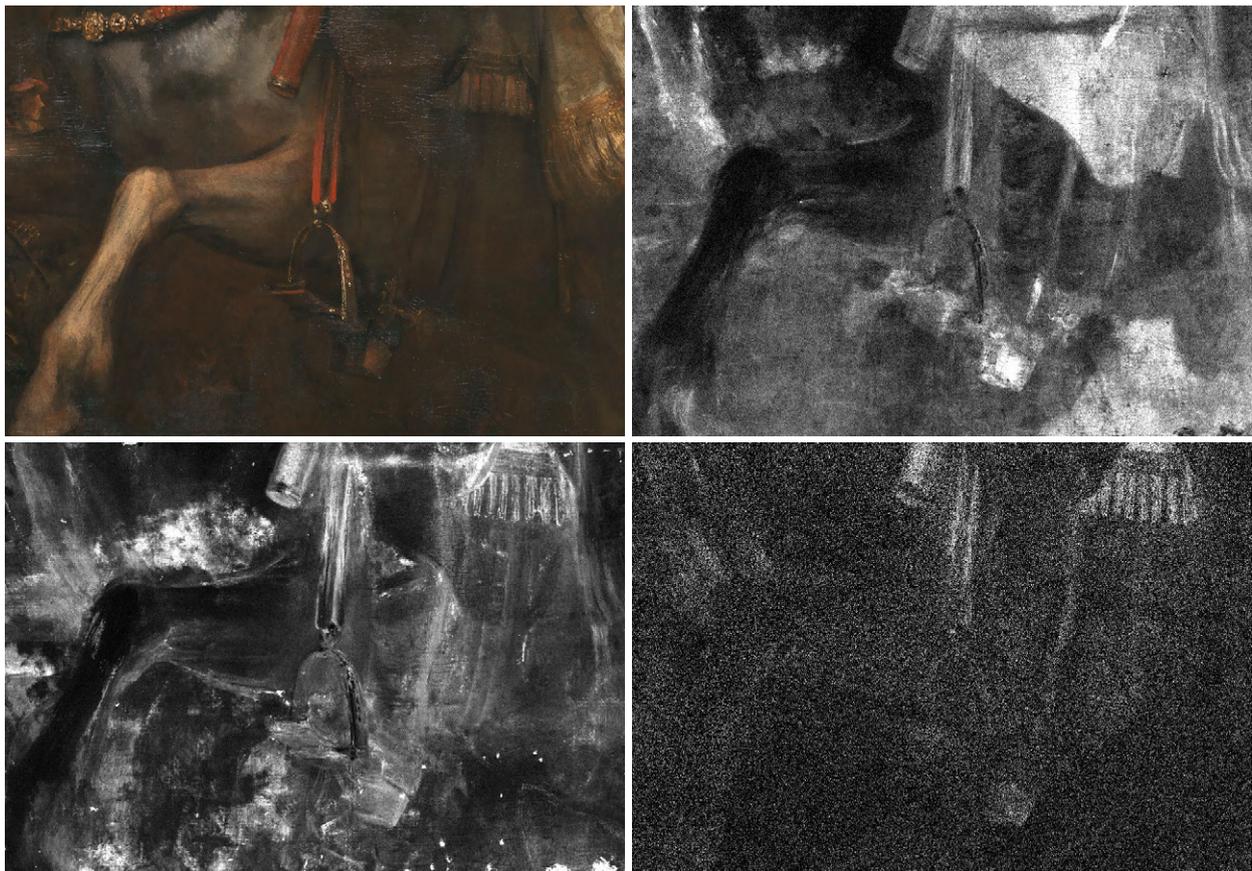


Figure 10 Rembrandt, *Portrait of Frederik Rihel on Horseback* (Fig. 1): detail of the horse's leg (*top left*) and XRF maps for potassium (*top right*), calcium (*bottom left*) and sulphur (*bottom right*). Photos © The National Gallery, London.

and the painting below it with the hidden figure. Macro-XRF has also revealed another example of the use of different batches of smalt in Rembrandt's *Saul and David* from the Mauritshuis in The Hague.²⁹

Using macro-XRF, it was possible to explore the distribution of smalt in this painting by examining the XRF maps for cobalt, potassium, nickel and arsenic (the latter two are associated with the cobalt ore used to make the smalt) (Fig. 9). The cobalt, nickel and arsenic XRF maps are nearly identical and reveal the full extent of Rembrandt's use of smalt, especially in the final Rihel composition. Cobalt and nickel were found throughout the scanned area, with especially strong signals in the foliage surrounding the horse and in the area of the carriage in the bottom left. All three XRF maps show a strong signal in the area under the horse's belly; it is unclear what this represents but it possibly indicates an area of foliage in the Rihel painting that has since discoloured. This pervasive use of smalt goes some way to explaining the current degraded state of these passages on the painting, especially in the area of the carriage, which has

become so murky that the vehicle and its figures are now barely visible.³⁰ Similar degraded smalt-containing paint layers have been observed in other pictures by Rembrandt.³¹

While the cobalt and nickel – and to a slightly lesser extent the arsenic – XRF maps indicate the presence of smalt throughout the surface composition, the potassium XRF map (and the arsenic map to some degree) provide a clearer visualisation of the concealed composition. In these maps, the background paint surrounding the hidden figure and outlining his head, shoulders, proper right arm and staff is revealed. Potassium is not normally a reliable indicator of *pentimenti* and hidden paint layers as it produces relatively low energy fluorescence X-rays that are easily obscured by overlaid paint layers. The reason the potassium signal can be detected in this particular passage (showing the outline of the hidden figure) is because it lies underneath the horse's belly and hindquarters which appear to be painted in pigments composed of elements that are relatively X-ray transparent (i.e. that do not absorb X-rays efficiently).

Red lake pigments are richly coloured, translucent but fugitive pigments prepared from organic dyestuffs that were often used by Rembrandt to create lush, glazy red colours.³² Elemental analysis techniques can sometimes be helpful in identifying the substrate for the dyestuff in red lake pigments (e.g. detection of aluminium or calcium associated with the typical hydrated alumina or chalk-based substrates), or might detect other elements related to their method of manufacture (such as potassium or sulphur remaining from the alum used as a raw ingredient).³³ While previous cross-section analyses had identified red lake pigment in samples from this painting, the full extent of their use was not apparent until a closer examination was made of the potassium XRF map (Fig. 10, top right). The highlights in the horse's breast, the scabbard and the stirrup straps all show clear signals for potassium in regions that do not correspond to the cobalt, nickel or arsenic XRF maps, indicating that they do not relate to the use of smalt. The calcium and sulphur XRF maps provide further evidence to support this possible identification of the use of lake pigments (see Fig. 10, bottom row).³⁴ Many areas of the final portrait which correspond to regions with a high signal in the potassium and sulphur XRF maps have a translucent red appearance in the finished picture consistent with the use of red lake pigments, such as the red highlights in Rihel's boot heel, tip, stirrup strap and sword sheath. These areas also correlate with the calcium XRF map, suggesting either that calcium is present in the red lake itself or a calcium-containing material is mixed in with the lake. Some of these results were supported by earlier cross-section analysis, as in the case of the stirrup strap, which was confirmed to contain a potassium-rich red lake, also containing calcium and sulphur.

There is also a signal in the calcium and potassium XRF maps (and faintly in the sulphur map) in the region of the horse's breast that corresponds to an almost invisible set of shadows on the painting. It is possible that this indicates the presence in this area of a lake pigment that has now faded, and if so, this usage would have remained unidentified had it not been for the use of macro-XRF.

Previous cross-section analyses of this picture have also identified lake pigments in the lower paint layers corresponding to the hidden composition, including the rarely confirmed use of a brazilwood lake.³⁵ Red lake pigments have also been found in the

flesh paints of other Rembrandt portraits, presumably using this pigment in the place of vermilion to create a pink tone.³⁶ Unfortunately there is no clear evidence in any of the XRF maps for the presence of lake pigments in paint associated with the hidden composition (from the man's face or anywhere else), in part because of the low proportion of potassium typically present and also the low energy of the fluorescence X-rays emitted by the lake-related elements (potassium and sulphur), which are readily shielded from the instrument by intervening paint layers. The potassium that is detected in these areas seems to be from the smalt in the background rather than any red lake, likely reflecting the greater proportion of potassium present in the smalt used compared to the red lakes, or the more liberal application of the pigment.

The results presented here provide new insights into Rembrandt's pigment use and greater clarity to the visualisation of the hidden composition. While the hidden figure's features are much more legible, these results also increase uncertainty about his identity. If this sitter is not Frederik Rihel, then who is he? Further context for the materials identified in the lower third of the Rihel painting that has so far been scanned using macro-XRF would be gained if the rest of the picture were to be examined using this technique, which might also help to better understand the underlying composition and to explore the art-historical questions about the sitter's identity.

Acknowledgements

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Notes and references

1. Bomford, D., Roy, A. and Brown, C. with contributions from Kirby, J. and White, R. (1988), *Art in the Making: Rembrandt*, 1st edn, London, National Gallery Company: 134–9; Bomford, D., Kirby, J., Roy, A., Rüger, A. and White, R. (2006), *Art in the Making: Rembrandt*, 2nd edn, London, National Gallery Company; Maclaren, N., rev. edn. by C. Brown (1991), *National Gallery Catalogues: The Dutch School 1600–1900*, vol. 1. London, National Gallery Company: 358–62.

2. Wieseman, M.E. (2010), 'Rembrandt's portrait(s?) of Frederik Rihel', *National Gallery Technical Bulletin* 31: 96–111.
3. Van der Wetering, E. (2005), 'Rembrandt's self-portraits: problems of authenticity and function', *A Corpus of Rembrandt Paintings IV. The Self-Portraits*, Dordrecht, Springer: 96–7.
4. Wieseman 2010 (cited in note 2) 96.
5. *Ibid.*
6. When reusing his supports, Rembrandt sometimes, but not always, covered up the original composition with a 'blocking-out' layer. Ernst van de Wetering states that he most commonly painted directly on the earlier composition but might cover certain areas with opaque paint where necessary to avoid the first composition interfering with the subsequent work; see Van de Wetering 2005 (cited in note 3) 96. See also Dooley, K.A., Gifford, E.M., van Loon, A., Noble, P., Zeibel, J.G., Conover, D.M., Alfeld, M., van der Snickt, G., Legrand, S., Janssens, K., Dik, J. and Delaney, J.K. (2018), 'Separating two painting campaigns in Saul and David, attributed to Rembrandt, using macroscale reflectance and XRF imaging spectroscopies and microscale paint analysis', *Heritage Science* 6(1): 1–1515; MacLennan, D., Trentelman, K., Szafran, Y., Woollett, A.T., Delaney, J.K., Janssens, K. and Dik, J. (2018) 'Rembrandt's *An Old Man in Military Costume*: combining hyperspectral and MA-XRF imaging to understand how two paintings were painted on a single "panel"', *Journal of the American Institute for Conservation* 58(3): 1–15.
7. See the paper by Larry Keith in this volume.
8. Wieseman 2010 (cited in note 2) 109.
9. Macro-X-ray fluorescence scanning was undertaken using a Bruker M6 Jetstream macro-XRF scanner. The measuring head consisted of a 30 W Rhodium-target microfocus X-ray tube with a maximum voltage of 50 kV and a maximum current of 600 μ A. The tube was fitted with a polycapillary optic which allows a variable beam size (c.50–1000 μ m depending on the working distance used). Typical dwell times used were in the order of 5–25 ms. A 30 mm² silicon drift (SDD) X-ray detector was used with an energy resolution < 145 eV for Mn K α . The instrument can only detect elements heavier than silicon. By moving the measuring head on the x-y stage, a painting may be scanned line by line, pixel by pixel. The maximum scanning range for a single acquisition is 800 \times 600 mm. The final resolution obtained depends on both the beam size and the selected step size. See Alfeld, M., Pedroso, J.V., van Eikema Hommes, M., van der Snickt, G., Tauber, G., Blaas, J., Haschke, M., Erler, K., Dik, J. and Janssens, K. (2013), 'A mobile instrument for in situ scanning macro-XRF investigation of historical paintings', *Journal of Analytical Atomic Spectrometry* 28: 760–67.
10. During the period of loan of this instrument to the National Gallery, the macro-XRF scanner was used on multiple paintings, yielding significant results. Based on the success of this six-week loan period (and the resulting publications), the National Gallery was able to acquire its own macro-XRF in January 2017. See Spring, M., von Aderkas, N., Rukavina, F. and Peggie, D. (2017) '*An Astronomer* by Ferdinand Bol: materials, colour change and conservation', *National Gallery Technical Bulletin* 38: 76–95; Spring, M., Billinge, R., Treves, L., von Aderkas, N., Higgitt, C., van Loon, A. and Dik, J. (2016) 'Goya's portraits in the National Gallery: their technique, materials and development', *National Gallery Technical Bulletin* 37: 78–104.
11. For examples of the use of macro-XRF in understanding Rembrandt's reuse of supports see Alfeld, M., Siddons, D.P., Janssens, K., Dik, J., Woll, A., Kirkham, R. and van de Wetering, E. (2013), 'Visualizing the 17th century underpainting in *Portrait of an Old Man* by Rembrandt van Rijn using synchrotron-based scanning macro-XRF', *Applied Physics A* 111: 157–64; Trentelman, K., Janssens, K., van der Snickt, G., Szafran, Y., Woollett, A.T. and Dik, J. (2015), 'Rembrandt's *An Old Man in Military Costume*: the underlying image re-examined', *Applied Physics A* 121(3): 801–11, with an update in MacLennan et al. 2018 (cited in note 6). For some of the other studies of Rembrandt using macro-XRF see Uhlir, K., Gironde, M., Bombelli, L., Eder, M., Aresi, N., Groschner, G. and Griesser, M. (2019), 'Rembrandt's *Old Woman Praying*, 1629/30: a look below the surface using X-ray fluorescence mapping', *X-Ray Spectrometry* 48: 293–302; Janssens, K., van der Snickt, G., Alfeld, M., Noble, P., van Loon, A., Delaney, J., Conover, D., Zeibel, J. and Dik, J. (2016), 'Rembrandt's "Saul and David" (c.1652): use of multiple types of smalt evidenced by means of non-destructive imaging', *Microchemical Journal* 126: 515–23; Noble, P., van Loon, A., van der Snickt, G., Janssens, K., Alfeld, M. and Dik, J. (2014), 'Development of new imaging techniques of the study and interpretation of late Rembrandt paintings', in *Preprints of the ICOM-CC 17th Triennial Conference*, ed. J. Bridgland, Paris, International Council of Museums: art. 1310; Alfeld, M., Laurenze-Landsberg, C., Denker, A., Janssens, K. and Noble, P. (2015), 'Neutron activation autoradiography and scanning macro-XRF of Rembrandt van Rijn's *Susanna and the Elders* (Gemäldegalerie Berlin): a comparison of two methods for imaging of historical paintings with elemental contrast', *Applied Physics A* 119(3): 795–805.
12. In this study, scans were carried out at 50 kV and 600 μ A beam current, a 50 ms dwell time and a 1000 μ m step size with a beam size of approximately 860 μ m. The resulting datacubes were processed, and elemental distribution maps created using a combination of PyMCA and Datamuncher software packages (cited below). Elemental distribution maps were generated by selecting particular element lines from the XRF sum spectrum of all datacubes and fitting using dynamic

- analysis on each of the nine datacubes. The element maps from the nine scanned regions were mosaicked together and further manipulated (e.g. adjusting intensities for seamless mosaicking) using the glue function in Datamuncher before being output as 16-bit greyscale images. See Solé, V.A., Papillon, E., Cotte, M., Walter, P. and Susini, J. (2007), 'A multiplatform code for the analysis of energy-dispersive X-ray fluorescence spectra', *Spectrochim Acta Part B* 62(1): 63–8 and Alfeld, M. and Janssens, K. (2015), 'Strategies for processing mega-pixel X-ray fluorescence hyperspectral data: a case study on a version of Caravaggio's painting *Supper at Emmaus*', *Journal of Analytical Atomic Spectrometry* 30: 777–89.
13. Wieseman 2010 (cited in note 2) 104.
 14. Roy, A. and Kirby, J. (2006), 'Rembrandt's palette', in Bomford *et al.* 2006 (cited in note 1) 43, 45–7.
 15. The copper XRF map in Figure 3 has been adjusted to show the copper signal in the folds of the hidden man's clothes but the signal is much weaker than in the background paint passages, which are rich in copper-based pigments. For the use of copper-containing pigments as driers see Roy and Kirby 2006 (cited in note 14) 45.
 16. Wieseman 2010 (cited in note 2) 106.
 17. Another cross-section from outside the area of the macro-XRF scan (in the top right of the finished painting) also showed a paint layer corresponding to what is probably foliage in the hidden painting and contained azurite with yellow ochre and smalt: Bomford *et al.* 2006 (cited in note 1) 186–9. For more on Rembrandt's use of blue pigments, see Roy and Kirby 2006 (cited in note 14) 45.
 18. Spring *et al.* 2017 (cited in note 10) 88.
 19. Wieseman 2010 (cited in note 2); see also the paper by Larry Keith in this volume.
 20. Wieseman 2010 (cited in note 2) 105.
 21. The shape is present in the lead L-line map (indicating the subsurface lead components) but not the lead M-line map (associated with the lead in the surface layers) suggesting that it is in the hidden composition.
 22. Wieseman 2010 (cited in note 2) 105.
 23. Noble *et al.* used the manganese XRF map to show how Rembrandt used areas of exposed ground layer to create modelling effects. Unfortunately, there was no manganese in the ground layer in the National Gallery painting: Noble *et al.* 2014 (cited in note 11).
 24. Bone or ivory black should also contain phosphorus but in this case the phosphorus XRF map does not reveal any appreciable signal (not shown). While in some previous studies it has been possible to map bone or ivory black using macro-XRF through the phosphorus and calcium XRF maps showing similar distributions (e.g. Noble *et al.* 2014 [cited in note 11] 5), the detection of phosphorus will depend on the instrument setup and is particularly problematic where the pigment is not present in a surface layer.
 25. Roy and Kirby 2006 (cited in note 14) 39.
 26. Using macro-XRF, Trentelman *et al.* found mercury in the flesh paint of the hidden painting in *An Old Man in Military Costume* at the J. Paul Getty Museum, and Alfeld *et al.* found it in *Susanna and the Elders*. However, Noble *et al.* found no mercury in the pink skin of *Self-Portrait* at the Mauritshuis. See Trentelman *et al.* 2015, Alfeld *et al.* 2015 and Noble *et al.* 2014 (all cited in note 11).
 27. Van Loon, A., Noble, P. and Boon, J.J. (2011), 'White hazes and surface crusts in Rembrandt's *Homer* and related paintings', in *Preprints of the ICOM-CC 16th Triennial Conference*, Paris, International Council of Museums [CDROM]; Roy and Kirby 2006 (cited in note 14) 44–5.
 28. Spring, M., Higgitt, C. and Saunders, D. (2005), 'Investigation of pigment–medium interaction processes in oil paint containing degraded smalt', *National Gallery Technical Bulletin* 26: 56–70.
 29. Janssens *et al.* 2016 (cited in note 11).
 30. The degradation of smalt on the *Portrait of Frederik Rihel on Horseback* has already been noted in Bomford *et al.* 2006 (cited in note 1) 189.
 31. Van Loon *et al.* 2011 (cited in note 27). See also Janssens *et al.* 2016 (cited in note 11).
 32. Kirby, J., Spring, M. and Higgitt, C. (2005), 'The technology of red lake pigment manufacture: study of the dyestuff substrate', *National Gallery Technical Bulletin* 26: 71–87.
 33. *Ibid.*
 34. Aluminium, present in some form of hydrated alumina in many lakes, is unfortunately too low in atomic mass to be properly identified using macro-XRF. The calcium and sulphur XRF maps were useful for identifying lake pigments at the surface of the painting, but neither element results in X-ray fluorescence of sufficient energy to provide clear maps for the lower layers. See Alfeld *et al.* 2013 (cited in note 10) 763.
 35. See the paper by David Pegg and Jo Kirby, in this volume; see also Bomford *et al.* 2006 (cited in note 1) 189; Wieseman 2010 (cited in note 2).
 36. Noble *et al.* 2014 (cited in note 11) 5.

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