

Review Article

Johannes Vermeer of Delft [1632-1675] and vision in neuroendoscopy

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Abstract

Background: Johannes Vermeer of Delft [1632-1675] was one of the greatest Masters of the Dutch Golden Age who was intensely preoccupied with the behavior of light and other optical effects and was entitled “The Master of Light”. He fastidiously attended to the subtleties of visual expression through geometry, composition, and precise mastery of the rules of perspective. It has been our impression that some visual similarity does exist between neuroendoscopic images and some of Vermeer’s paintings. Such a relation could be explained by the fact that optical devices are utilized in producing both types of display.

Methods: We reviewed the pertinent medical and art literature, observed some video clips of our endoscopy cases, and inspected digital high resolution images of Vermeer’s paintings in order to elaborate on shared optical phenomena between neuroendoscopic views and Vermeer’s paintings.

Results: Specific optical phenomena are indeed shared by Johannes Vermeer’s works and neuroendoscopic vision, namely light and color effects as well as the rules of perspective.

Conclusion: From the physical point of view, the possibility that a *camera obscura* inspired Vermeer’s artistic creation makes the existence of a visual link between his paintings and the endoscopic views of the intracranial cavity comprehensible.

Key Words: Light, neuroendoscopy, Vermeer, vision

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Quick Response Code:**INTRODUCTION**

Johannes Vermeer of Delft [1632-1675] was one of the greatest Masters of the Dutch Golden Age and unquestionably the most talented genre painter in Holland during the seventeenth century.^[4] He was intensely preoccupied with the behavior of light and other optical effects^[13] so that he was entitled “The Master

of Light” by some contemporary art scholars.^[20] He fastidiously attended to the subtleties of visual expression through geometry, composition, and precise mastery of the rules of perspective.^[30] Vermeer most probably used a *camera obscura* in observing the views he painted and was likely influenced by the Dutch scientist and lens maker Antonie van Leeuwenhoek [1632-1723] who lived in the same city of Delft during Vermeer’s life.^[8,19,20]

On contrary to the preceding and contemporary painters' works, Vermeer paintings were uniquely characterized by a profound optical realism that created a compelling sensation of objects being seen, not simply depicted [Figure 1].^[14,21,33] This feature was extremely eminent so that some of his works were even described to exhibit a certain photographic quality.^[18,19]

Comparably, when endoscopes were used intracranially for the first time, neurosurgeons witnessed a world of unique visual experience that they have never encountered before. Such visual realm subsequently developed into an unprecedented level of definition in displaying pathoanatomical details offered by the state-of-the-art rod-lens endoscopes.^[2,25]

It has been our impression that some visual similarity does exist between neuroendoscopic images and some of Vermeer's paintings [Figures 2 and 3]. Although this may seem subjective, such a relation could be explained by the fact that optical devices are utilized in producing both types of display. Specific optical phenomena are indeed shared by Johannes Vermeer's works and neuroendoscopic vision, namely light and color effects as well as the rules of perspective. Since we believe that exploring such a relation touches an artistic and aesthetic aspect of neurosurgery that is worth exposure and analysis, we searched the pertinent medical and art literature, reviewed video clips of our endoscopy cases, and inspected digital high resolution images of Vermeer's paintings in order to elaborate on these shared optical phenomena. It should be emphasized that this work is a discussion of the philosophy of vision in neuroendoscopy and Vermeer's artistic creation and is not intended to imply that the two visual outputs are identical.

Endoscopic images "come to life" by the same Claire-obscure light as in the paintings of the Baroque masters like Vermeer,

but the same phenomena can be seen in paintings by his contemporaries, Rembrandt van Rijn, Jacob van Ruisdael, Frans Hals, and Jan Steen. They also had a remarkable knowledge of the interplay of light and dark, they also often used sharp contrasts as to lead the viewer into the scenery, resulting in vivid scenes full of drama.

Light and color effects in neuroendoscopy and in Vermeer's works

Light and color are basic elements of the process of visualization in neuroendoscopy^[7] as they certainly are in Vermeer's work. In this context, it is important to take in consideration that Vermeer is known to have learnt the relationships of light and shadow through several forms of experience including observing images produced by optical devices of his time.^[15]

Vermeer had a strong preference for cornflower blue and lead-tin yellow. In the seventeenth century, many pigments had to be imported from far and hence they were expensive, like the ultramarine blue from Afghanistan, the umber (earthy brown) color from Umbria in Italy, indigo from Asian countries such as India, and a very precious yellow pigment made by heating red lead and tin dioxide. This yellow color is famous from the yellow jackets he has painted in several paintings, the most well-known being *The Milkmaid*.

Light effects

In endoscopic neurosurgery, the endoscope brings the light source and lens closer to the pathology providing brightly illuminated and detailed panoramic views of the target structure within its intracranial environment [Figure 4].^[23-26] This is peculiarly similar to Vermeer's method of placing human figures in a coherent three-dimensional space filled with natural light [Figure 5].^[9] Such immersion in light made art critics describe objects in Vermeer's interior views

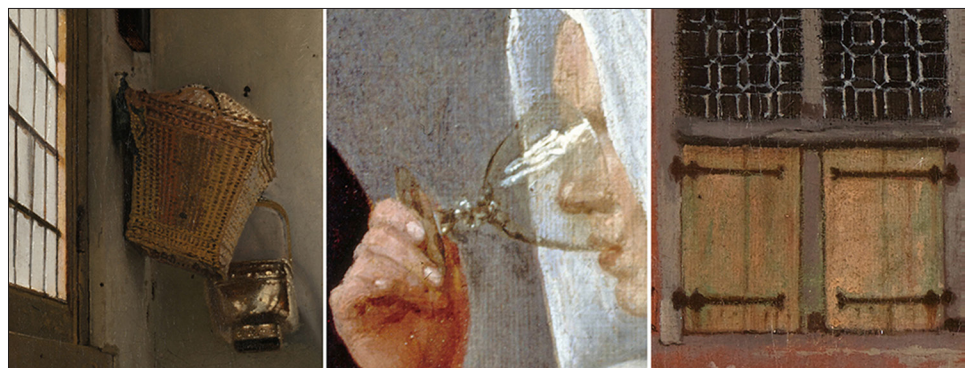


Figure 1: Sense of reality in Vermeer's works. Left: Detail from *The Milkmaid*. Note the almost real appearance of the hanging basket, the copper vessel and the broken glass of the window. (With permission from Rijksmuseum, Amsterdam, The Netherlands). Middle: Detail from *The Glass of Wine*. Note the reflection of light on the glass and the lady's nail paint. (Photo credit © bpk - Bildagentur für Kunst, Kultur und Geschichte, Berlin - Staatliche Museen, Gemäldegalerie, Berlin - Jörg P. Anders - Johannes (Jan) Vermeer van Delft, *Das Glas Wein*). Right: Detail from *The Little Street*. The rusty metal hinges of the wooden window shutters contribute to the wary appearance of the old house. (With permission from Rijksmuseum, Amsterdam, The Netherlands)

as being bathed in cool pearlescent light^[21] that characteristically infuses space, color, and form with a luminous unity^[33] and is in complete accordance with the laws of physics [Figures 5-8].^[32]

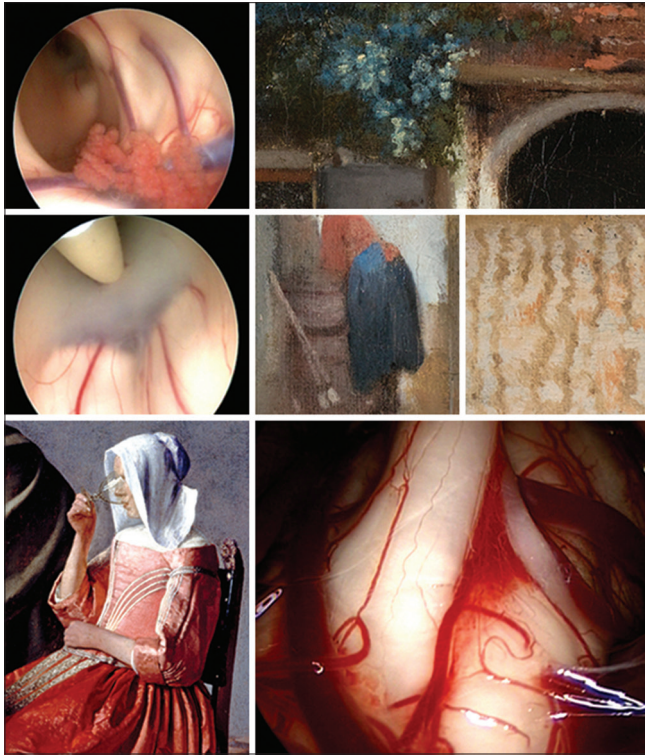


Figure 2: Similarity between endoscopic views and Vermeer's paintings. Details from *The Little Street*, Upper and Middle Panels. (With permission from Rijksmuseum, Amsterdam, The Netherlands). The vine tree sloping down onto the open window shutter and the door frame directs the viewer inside the house (Upper Right), as the choroid plexus leads visually into the foramen of Monro in the endoscopic view obtained during an endoscopic third ventriculostomy (Upper Left). The blue color of the thalamostriate vein in the endoscopic view echoes to the color of the vine tree intensifying the sense of optical similarity. Further into the house, a maid is washing at the end of the alleyway and an unused broom is ready to be held in action (Middle Center) simulates the Fogarty's catheter about to penetrate the third ventricular floor down in the depth (Middle Left). Note how the tiny vascular pattern on the surface of the mamillary bodies simulates the rows of weary cobblestone in front of the building (Middle Right) contributing to a sense of slow motion directed towards a deeper level of both scenes. (With permission from Rijksmuseum, Amsterdam, The Netherlands). Lower Left, Details from *The Glass of Wine*, Staatliche Museen, Gemäldegalerie, Berlin, and an endoscopic view during microvascular decompression for trigeminal neuralgia (Lower right). The subtle grades of white and off-white of the brainstem and trigeminal nerve notably simulate the whites of the head cap and the white garment covering the upper chest and shoulders of the lady. Compare the blood vessels converging into and encircle the trigeminal nerve in the endoscopic view to the postures of the lady's arm encircling her torso. The red hues of the blood vessels against the background color of neural tissue in the endoscopic view and the reds of the dress and its folds greatly enhance the sense of similarity. (Photo credit © bpk - Bildagentur für Kunst, Kultur und Geschichte, Berlin - Staatliche Museen, Gemäldegalerie, Berlin - Jörg P. Anders - Johannes (Jan) Vermeer van Delft, Das Glas Wein)

Vermeer's depiction of windows through which light flows into his interior scenes is a very special feature of his art^[21] that shares an important conceptual relation to vision in neuroendoscopy. During neuroendoscopic procedures, strategically placed anatomical windows are created to precisely and deeply illuminate the objects within an intracranial chamber unveiling their visual details. Observing the known 35 works of Vermeer, we found that windows are the source of light in 15 paintings. In 10 other works, windows are present at a hidden part of the composition, in other words their presence can only be concluded by the viewer when light intensities and directions of shadows in the painting are followed.

Color effects

As high color fidelity contributes to producing true color neuroendoscopic images indispensable for real differentiation between various tissues [Figure 4B],^[25] Vermeer's remarkable sensitivity to color and his complete understanding of its optical characteristics^[35] made objects in many of his paintings look almost real [Figure 1].^[14,21] His coloring techniques clearly reflected Leonardo da Vinci's [1452-1519] observations that the surfaces of objects share the color of an adjacent object.^[34] Moreover, in human vision of the real world, colors are known to blend in the distance especially when they are in fine patterns or intermingled because color-processing neurons of the blob subsystem of the visual pathway are characterized by low acuity and inability to separate



Figure 3: Additional images with features of similarity. Details from *The Milkmaid*, upper and lower left. Compare each of the images to the corresponding endoscopic dissection image on the right. In the upper images, the low angle of view of the brain stem with close view resembles the woman's head. Note the woman's lower arm in comparison to the cranial nerve and the convergence into the milk vessel compared the jugular foramen in the endoscopic view. With permission from Rijksmuseum, Amsterdam, The Netherlands

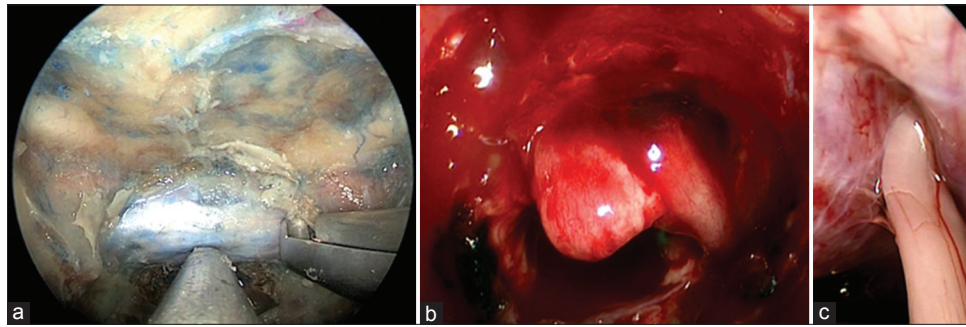


Figure 4: Examples of intracranial endoscopic procedures.The endoscope brings the light source and lens close to the area of interest and provides brightly illuminated and detailed panoramic views of the target structure within its intracranial environment. (a) Endoscopic endonasal sellar approach in a cadaveric specimen. (b) Endoscopic endonasal excision of a pituitary macroadenoma. Note the demarcation between the pituitary gland and tumor tissue. (c) Endoscopic image of the trigeminal nerve in Mickle's cave during an endoscope-assisted microvascular decompression



Figure 5: A Girl Reading a Letter by an Open Window. Johannes Vermeer, circa 1657, oil on canvas, 83 × 64.5 cm, Gemäldegalerie Alte Meister, Staatliche Kunstsammlungen, Dresden, Germany. Photo Credit: Erich Lessing, Art Resource, New York, NY, USA

hues in the distance.^[3] Vermeer actually utilized this phenomenon in many of his paintings. For instance, a close observation reveals that small touches of white, light ochre, reddish brown, brown, and greenish gray join together to build the form of the naturally looking face of the lady in *The Milkmaid* [Figure 7].^[11]



Figure 6: The Milkmaid. Johannes Vermeer, circa 1658-1661, oil on canvas, 45.5 × 41 cm, Rijksmuseum, Amsterdam, The Netherlands. With permission from Rijksmuseum, Amsterdam, The Netherlands

Technical examinations revealed that Vermeer generally applied a gray or ochre ground layer over the canvas to establish the color harmonies of the composition and created translucent effects by applying thin glazes over these layers to achieve such an outstanding luminosity of his works.^[36] One of Vermeer's discoveries was that blue color enforces the sense of light. In some of his paintings, analyses revealed that a little of blue exists in every color to produce a feeling of daylight flowing over every surface [Figure 8].^[33]

PERSPECTIVE IN NEUROENDOSCOPY AND IN VERMEER'S WORKS

Vision in neuroendoscopy depends largely on the rules of perspective where the view of a given anatomical region or structure is altered by changes in the viewing angle of the lens and the trajectory of the endoscope shaft [Figure 9]. Vermeer used linear perspective in a flexible manner that enabled him to depict sudden shifts between the close and the distant in a way comparable to normal vision; a well-known example is his *Officer and a Laughing Girl*, in which the composition was described as similar or even typical of photography.^[14] The perspective of the interiors is thought by art historians to represent a unique feature of Vermeer's work since it offers the viewer an opportunity to realize the given reality.^[31]

It is notable that Vermeer reinforced the depth of most of his paintings by making use of a foil, a chair, or a curtain. Vermeer had (like his contemporary Gerard de Lairese) a theoretical interest in painting and a notable interest in maps.

Vantage points

In endoscopic neurosurgery, a customized entry point is determined, which enables reaching a particular intracranial environment, that is, the area in which work is to be performed under direct vision.^[22] Vermeer, in a closely similar fashion, carefully places a vantage point (the point from which we look at the scene) and manipulates the perspective to emphasize a certain

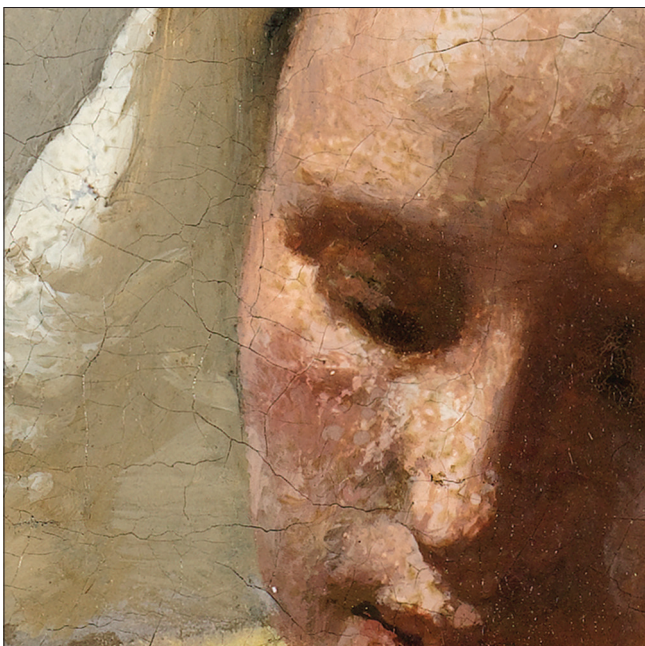


Figure 7: Detail from *The Milkmaid*. Small touches of white, light ochre, reddish brown, brown, and greenish gray join together to build the form of the naturally looking face of the lady. With permission from Rijksmuseum, Amsterdam, The Netherlands

character or express a specific idea.^[36] In his famous masterpiece, *The Milkmaid*, a low vantage point and a pyramidal construction of forms from the left foreground to the woman's head lend her monumentality and perhaps a sense of dignity [Figure 6].^[11,16] In *The Glass of Wine*, Vermeer increases the feeling of immediacy by fixing the vantage point quite close to the picture plane making the space recede abruptly from near at hand [Figure 8].^[17] Even in his rare outdoor paintings like *The Little Street*, a sense of inescapable closeness that symbolizes the virtues of home life is achieved through a frontal vantage point [Figure 10].^[10]

Digital verification of precision

The accurate portrayal of three-dimensional space through perspective has recently been understood to have played a more important role in Vermeer's art than it was previously thought.^[12] In a computer-generated three-dimensional version of *The Music Lesson*, the orthogonals are all found to lead back to the woman who is the main focus of the composition, the vanishing point is on her sleeve, and even the tiles on the floor recede to her.^[21] A digital parametric reconstruction of the architectural space depicted in Vermeer's *A Girl Reading a Letter by an Open Window* revealed that the horizon divided the canvas almost exactly into two halves and the perpendicular line through the girl's center of gravity (passing through her ear) divided the canvas into two halves.^[18] A further astounding example was brought about by a computer-aided analysis of the geometry and perspective in *The Art of Painting*, which revealed that the precision of the depicted floor tiles had a mean error of about ± 1.0 mm at the grid of tiles.^[5]



Figure 8: *The Glass of Wine*, Johannes Vermeer, circa 1661-1662, oil on canvas, 65 × 77 cm, Staatliche Museen, Gemäldegalerie, Berlin. (Photo credit © bpk - Bildagentur für Kunst, Kultur und Geschichte, Berlin - Staatliche Museen, Gemäldegalerie, Berlin - Jörg P. Anders - Johannes (Jan) Vermeer van Delft, Das Glas Wein)

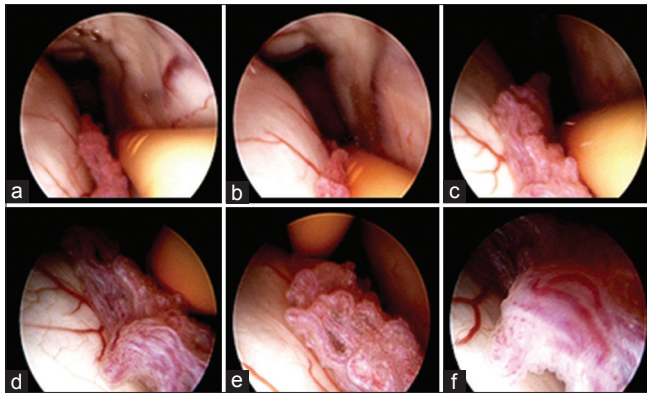


Figure 9: Vision in neuroendoscopy and the rules of perspective. Images from a case of endoscopic shunt insertion into an isolated temporal horn (a-f). Note the alteration of the views of the choroid plexus and the ventricular catheter brought about by changes in the trajectory of the endoscope shaft

The camera obscura

It has been speculated that Vermeer used a room-type *camera obscura* to actually trace many of his works from its screen.^[1,6,27,28,29,37] The remarkably perfect linear perspective displayed by many of Vermeer's interior scenes was the basis for such a belief among the scholars who presumed that freehand painting and drawing, unless aided in some way, cannot approach this accuracy.^[19] It was, however, argued that the extreme precision of the floor tiles in *The Art of Painting* makes it highly questionable that a device with the technology of the seventeenth century could produce such a high precision painting.^[5] In addition, convex lenses available in the seventeenth century had diameters of about 4 cm; the use of such lenses in a large-scale *camera obscura* would result in images that are not only too dim for an effective visual inspection but also distorted by problems of inversion, reversal, and depth of focus.^[19] The laws of composition and artistic intuition in Vermeer's work seem to have stood much higher than just copying a *camera obscura* depiction.^[5] Vermeer could not have traced his interiors directly at full size from the screen of a *camera obscura*, however, his composition and approach to linear perspective could have been stimulated by use of a small *camera obscura*.^[19]

CONCLUSION

From the physical point of view, the possibility that an optical device like a *camera obscura* inspired Vermeer's artistic creation makes the existence of a visual link between the atmospheres prevailing in his interiors and the endoscopic views of the intracranial cavity comprehensible. Philosophically, the Dutch interiors that were in reality dim by Vermeer's time became deeply and richly lightened in his works exactly as the previously dark intracranial cavity became vibrantly and beautifully illuminated by the endoscopes. Johannes Vermeer's quest for a clearer



Figure 10: The Little Street, also known as View of Houses in Delft Johannes Vermeer, circa 1657-1661, oil on canvas, 53.3 × 44 cm, Rijksmuseum, Amsterdam, The Netherlands. With permission from Rijksmuseum, Amsterdam, The Netherlands

view of what he observed and subsequently depicted in his art on one hand and the continued evolution of neuroendoscopy on the other hand are genuine and beautiful representations of the everlasting endeavor of humanity towards a deeper look into the universe.

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