

Reflections on praxis and facture in a devotional portrait diptych: A computer analysis of the mirror in Hans Memling's *Virgin and Child and Maarten van Nieuwenhove*

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ABSTRACT

Hans Memling's 1487 diptych *Virgin and Child and Maarten van Nieuwenhove* is one of the most celebrated Early Netherlandish paintings, but little is known about the practical use of such objects in late medieval devotional practice. A particular point of debate, spurred by the reflection in the painted convex mirror behind the Virgin, concerns the question if the two hinged panels were to be used while set at an angle, and, if so, at what angle. It was recently discovered that the mirror was not part of the painting's initial design, but instead added later by Memling. We created a simple computer graphics model of the tableau in the diptych to test whether the image reflected in the mirror conformed to the image of the model reflected in the mirror. We find two significant deviations of the depicted mirror from that predicted from our computer model, and this in turn strongly suggests that Memling did not paint the mirror in this diptych while viewing the scene with a model in place, but that the mirror was more likely painted without a model present. In short, our findings support the notion that the mirror was an afterthought. This observation might have implications for the understanding of how the diptych was used in devotional practice, since it affects the ideal viewing angle of the wings for the beholder.

Keywords: Hans Memling, convex mirror, *Diptych of Maarten van Nieuwenhove*, computer graphics, Renaissance art, devotional praxis

1. INTRODUCTION

Convex mirrors begin to appear prominently in the paintings of the early Northern Renaissance, as symbols of wealth, as metaphors for an all-seeing Deity, as objects of inherent visual interest and as showpieces for artists' technical mastery. Prominent examples from the north and, somewhat later, Italy include:

- Jan van Eyck, *Portrait of Giovanni (?) Arnolfini and his wife* (1434)
- Robert Campin, *Heinrich von Werl and St. John the Baptist* (1438)
- Petrus Christus, *Saint Eligius* (1449)
- Hieronymus Bosch, *The seven deadly sins* (c. 1480)
- Hans Memling, *Vanity* (c. 1485) and *Maarten van Nieuwenhove diptych* (1487)
- Quentin Metsys, *The money lender and his wife* (1514)
- Parmigianino, *Self-portrait in a convex mirror* (c. 1524)
- Laux Furtenagel, *Hans Burgkmair and his wife* (1527)
- Pieter Bruegel the Elder, *Prudence* (1559)
- Caravaggio, *Martha and Mary Magdalene* (c. 1598)

Plane mirrors have appeared in European painting as well, of course, but there seem to be few if any clear depictions of *concave* mirrors around this time.

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Figure 1. Hans Memling, *Virgin and Child and Maarten van Nieuwenhove* (1487). Wood panels, 52.5 × 41.5 cm each (including the original frames). Municipal Museums, Bruges, Hospitaalmuseum Sint-Janshospitaal; image courtesy President and Fellows, Harvard College. The two hinged panels appear to depict a single, unified space, since the Virgin’s red robe and the stone parapet with the carpet in the foreground continues over both panels. The steep geometric perspective in the right wing is split into two fairly well defined vanishing points that are located in the left panel: the vanishing point defined by the sill and base of the rear window is somewhat lower than the vanishing point defined by the rest of that window. Moreover, the vanishing point defined by the sill and panes of the near window is a bit higher than that for the rear window. In the unified space of the full diptych, the donor sits to the Virgin’s left and is turned towards her. He appears to be situated in the same plane as the Virgin, immediately behind the parapet. The convex mirror, on the other hand, reflects a different spatial organization (cf., Figs. 2 and 7, below). Here, the Virgin and the donor are seated at two perpendicular sides of the same table. In the mirror’s reflection, both figures are silhouetted against bright window-like features, and it has been suggested that these features must represent the beholder’s space, as seen from the depicted space back through the picture frames. In 2006 it was discovered that the top left corner of the *Virgin and Child* was intensively reworked by Memling. X-ray and infra-red imaging reveals that the initial composition showed a similar window as the one on the right, and that the stained glass window with Van Nieuwenhove’s coat of arms, the window shutters, and the convex mirror were all added later, painted over a continuing landscape.

Recent computer image analyses of convex mirrors depicted in such art have shed light on a number of questions in the art history of the Renaissance. Criminisi and his colleagues modeled the optics of convex mirrors to dewarp the mirror images in Jan van Eyck’s *Portrait of Giovanni (?) Arnolfini and his wife* and Robert Campin’s *Heinrich von Werl and St. John the Baptist*.¹ They could then, in software, perform the inverse optical transform to correct or “dewarp” the image depicted in the mirror. This inverse transform depends upon the single unknown parameter R , the radius of curvature or “bulginess” of the mirror (cf., Fig. 4, below). (More accurately speaking, in their case the transform depends upon the unknown *ratio* of the facial radius to the radius of curvature.) They adjusted the computer model mirror’s radius of curvature such that door jams, windows, and so on in the reconstructed image were as rectilinear as possible. In this way they revealed—for the first time in nearly 600 years—new views into the respective tableau rooms. These authors found, nevertheless, that

even after best overall dewarping in *Arnolfini*, there remained slight distortions which could be attributed to the artist changing his viewing position, or that the mirror shape differed from the ideal, or that the artist's hand was not uniformly true while copying the reflected image. They found the reconstructed space in *Heinrich* conformed sufficiently well to the laws of perspective that they could use rigorous visual metrology to estimate the relative heights of figures in the mirror space.² They also used the visual information recovered from the dewarped images and a variety of other clues to reattribute this painting to Robert Campin.



Figure 2. Hans Memling, *Virgin and Child and Maarten van Nieuwenhove* (1487), detail, 22 × 44 cm. Notice that the mirror reflects the donor in the same room, silhouetted against the windows unifying the two panels. Image courtesy President and Fellows, Harvard College.

Stork extended such analyses to address David Hockney and Charles Falco's hypothesis that van Eyck used the very mirror he *depicted* within the painting to *execute* the rest of the painting by tracing a projected image.³ That is, they hypothesized that van Eyck turned the *convex* mirror around and used it as a *concave* projection mirror, to project an image of the tableau onto the oak panel support, trace it, and then fill it in with paint. Stork estimated the overall size of the mirror in *Arnolfini*; then together with the relative mirror curvature provided by Criminisi et al., he computed the absolute radius of curvature of this convex mirror, R . He then computed this mirror's focal length, f_{mir} , which in the paraxial ray approximation is simply $f_{mir} = R/2$.⁴ He also created a computer graphics model of the tableau to estimate the location and focal length of a putative optical projector for this painting, f_{proj} . He found these two focal lengths differed significantly, and thus he rejected the suggestion that van Eyck might have used the depicted mirror to build a projector for executing this painting. Stork also estimated the smallest blur spot of such a mirror and showed that this spot was too large—that is, the image too blurry—for an artist to trace the fine detail such is found in this painting.^{5,6}

Computer graphics models of tableaus of paintings have been used to answer art historical questions. Johnson et al. built a model of Vermeer's *Girl with a pearl earring*, and then adjusted the position of the model illuminant until the rendered model matched the painting most closely. In this way, they estimated the direction of the illumination. Their main goal, though, was to integrate estimation from a number of disparate sources such as the cast shadows, lightness along occluding contours, and lightness throughout an approximate facial model.⁷ Computer graphics has also answered questions in art unrelated to convex mirrors. Stork and Furuichi created a computer graphics model of Georges de la Tour's *Christ in the carpenter's studio*, and compared the rendered images with the light in two locations: in place of the depicted candle, and “in place of the other figure” (i.e., in place of Christ when St. Joseph was painted and vice versa).⁸ In this way they found that for this painting—and

for all others in de la Tour nocturne œuvre they tested—that the best fit position was at the candle. In this way they rebutted David Hockney’s optical projection claim, at least for *Christ in the carpenter’s studio*.

Simple computer image analysis (elementary perspective analysis) has addressed another art historical claim about Memling and mirrors, but in this case *concave* mirrors. David Hockney claimed that Memling executed *Flower still-life* (c. 1490) by means of tracing an image projected by a concave mirror. [3, pages 64–65] In support of his claim, Hockney pointed to the difference in location between the central vanishing point defined by the front half of the carpet and that defined by the back half of the carpet. He hypothesized that Memling refocussed a projector to overcome its limited depth of field and in doing so Memling tipped the projection mirror and thereby change the location of these central vanishing points. However, Stork did a full perspective analysis of the front half of the carpet, and of the back half of the carpet, which included tests for secondary vanishing points. This analysis showed that each portion of the carpet was not in proper perspective, though it should be if executed under optical projections.⁹ Such evidence thus rebuts Hockney’s optical projection claim.

In Sect. 2 we clarify the art historical question we address, one centered on the devotional practice associated with Memling’s diptych. As we shall see, its answer relies on an analysis of the image of the mirror depicted in its left panel. In Sect. 3 we describe our computer graphics modelling of the mirror and tableau. In Sect. 4 we present our results, and in Sect. 5 we present our conclusions and implications for the understanding of this diptych. We conclude by speculating on other art historical problems that might be addressed by such computer methods.

2. QUESTION

Many devotional half-figured portrait diptychs, such as Memling’s *Virgin and Child and Maarten van Nieuwenhove*, apparently did not function while hanging on a wall or column, nor were they fully opened with their wings placed at a straight angle of 180° when used in private devotional practice. Instead, such objects were often used in a standing position with its hinged wings at an obtuse angle and it has been suggested that this was also the case with Hans Memling’s famed diptych in Bruges. However, Memling introduced some remarkable pictorial discrepancies between the wings of his diptych which point to the possibility that this object was actually hung on a wall or column. In such a situation, the left wing with the Virgin and Child would have been secured to the wall in a stationary position, while the wing with the portrait of Maarten van Nieuwenhove could be opened and closed or otherwise manipulated.

The two hinged wings appear to depict a single, unified space, since the stone parapet in the foreground, decked with a carpet, continues over both panels. The donor’s prayer book is placed on a fold of the Virgin’s red robe that spills onto the right wing. In this unified space, the donor sits to the Virgin’s left and is turned towards her. He appears to be situated in the same plane as the Virgin, immediately behind the parapet. The reflection in the convex mirror belies such a spatial organization, however (cf., Figs. 2 and 8, below). Here, the Virgin and the donor are seated at *perpendicular* sides of a table rather than a parapet. Memling also used remarkably different perspective systems for the two wings of his diptych. On the right wing, the wall behind Maarten van Nieuwenhove is depicted in a relatively steep perspective, and its vanishing point is actually positioned on the left wing. The composition of the Virgin and Child, on the other hand, is in full frontal perspective, and the painter’s vantage point is located directly in front of the Virgin, on the panel’s vertical center line. Hence, the ideal viewing point of the entire diptych in its fully opened position is not located in front of the center of the diptych, but in front of the center of the left wing with the Virgin and Child. De Vos and others have suggested that the perspective system for Memling’s full diptych ‘falls into place’ when the beholder stands in front of the Virgin and Child while the right wing is placed at a more or less right angle (i.e., around 90°) from the left wing.¹⁰

We test to see whether the final reflected image, as it appears in the painting, does or does not conform to a simple computer graphics model of the tableau. Our technical question, then, is whether the mirror in the left panel of the diptych was painted with the subjects present, or instead added afterwards. This, in turn, comes down to the question of whether the image is highly consistent with the presence of a model, or inconsistent with the presence of a model. In the former case, the figural reference would likely give correspondence; in the latter case, the artist likely worked from memory or imagination.

We note in passing that a similar question applies to van Eyck’s *Arnolfini portrait*, specifically whether the room was *fictive* (in the artist’s imagination) or actually present. Despite some inconsistencies between the direct and de-warped reflected images,¹ the overall consistency between the *full room*, as drawn directly, and the reflection of the room, warped in the convex mirror was high.⁶ It would have been a pioneering artistic and visual accomplishment of the highest order if van Eyck could paint a fictive wedding room, and paint the distorted image in the mirror of a fictive room with the spatial consistency we find through the computer reconstructions. As such, it seems far more likely that van Eyck work from a real, physical room as referent than that he painted an imaginary or fictive room.

Recent technical examination of the diptych by means of infrared reflectography and X-radiography of the Memling diptych found further evidence that the reflections in the mirror do not depict an actual situation since the entire window behind the proper right shoulder of the Virgin was dramatically altered from its initial design. The stained glass window with Van Nieuwenhove’s coat of arms, the window shutters, and the convex mirror were all added later by Memling, painted on top of an earlier depicted window with mullions with a view on a landscape, which echoed the present window behind the Virgin’s proper left shoulder. The analogous question of praxis is more problematic for the mirror behind the Virgin in the left panel of Memling’s *Maarten van Nieuwenhove diptych* (1487). Notice that the reflected image does not display the warping that is most prominent around the perimeter of convex mirrors such as the van Eyck *Arnolfini*, the Metsys *Money lender*, and the Christus, *Saint Eligius* mirrors; nor does the dark gray color of the reflected image correspond to the Virgin’s red gown as it otherwise should.¹¹ In short, there are strong indications that the mirror was not part of the original design, but an afterthought by the artist.

3. COMPUTER GRAPHICS MODELLING

We have created a three-dimensional virtual environment in Maya (three-dimensional commercial modeling software) where the Mary is located (Fig. 3). We assume that the background of the painting (windows, wooden wall, etc.) is located on the left side wall of the virtual room, the background wall in the painting. This wall also contains the convex mirror. Furthermore, we assume that Mary is located somewhere between the background wall and the camera (observer). The relative positions of camera, Mary and background wall are constrained since the scene viewed from the camera must match the one in the diptych; in other words, their relative positions must be compatible with what we see in the diptych. Moreover, the amount of curvature in the (reflected) image of straight objects is another constraint.

Figure 3 shows the virtual setup for our computer graphics analyses. The overall scale is irrelevant to our investigations, but there are several other unknown sizes and positions, such as the position of the artist (“camera”), position and size of Mary, and facial size of the convex mirror. Moreover, we modeled the mirror as a section of a sphere, whose radius of curvature—its bulginess—is *a priori* unknown.

These unknown sizes and positions are constrained and such constraints allow us to infer their relative values. For instance, Fig. 4 shows the effect of the radius of curvature, R on the angle of view of the scene, and hence the relative sizes of objects. The theoretical analysis presented in¹² provides the tools for estimating a range of possible values of curvature given the measurements on the observer image plane (that is, the painting), location and orientation of the mirror and position of the reflected scene. Measured quantities can be, for instance, the location of feature points such as corner points in the image plane.

There is another parameter we can account for. The mirror curvature R doesn’t change the scale of the reflected scene only. It also induces a deformation on the reflected scene: straight lines are reflected as curves and the shorter the radius of curvature the more severe the deviation. This is, then, another constraint on our configuration. The analytical expressions in¹² allow predicting values for R given a geometrical configuration (observers view direction, distance of the mirror from the observer, distance of the reflected scene from the observer). The best value for R may be then inferred by minimizing the deviation of the predicted position of feature points (e.g., corner points) from their measurements in the painting. Figure 5 shows sample configurations we explored. We found that the one that best matched the image data (the distortion in the convex mirror and the relative sizes of objects and positions) is configuration (d), at the lower right.

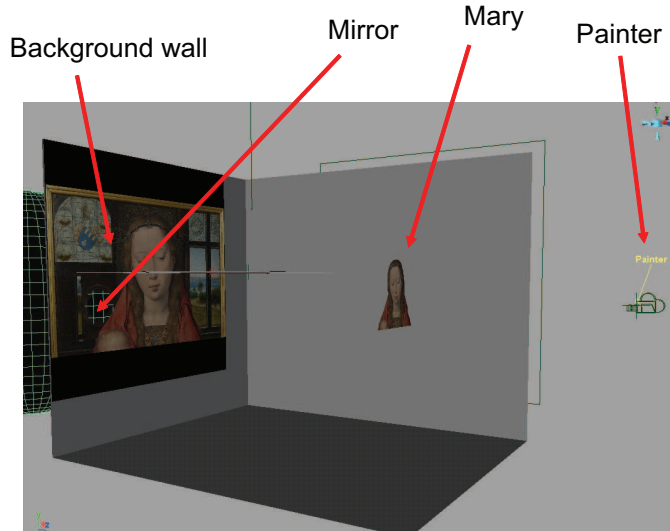


Figure 3. We modeled the full virtual environment for the left panel of the diptych as a flat back wall, a planar Mary, and a protruding convex mirror whose radius of curvature is estimated so as to conform with other image data. The artist's viewing position is indicated by the camera at the right.

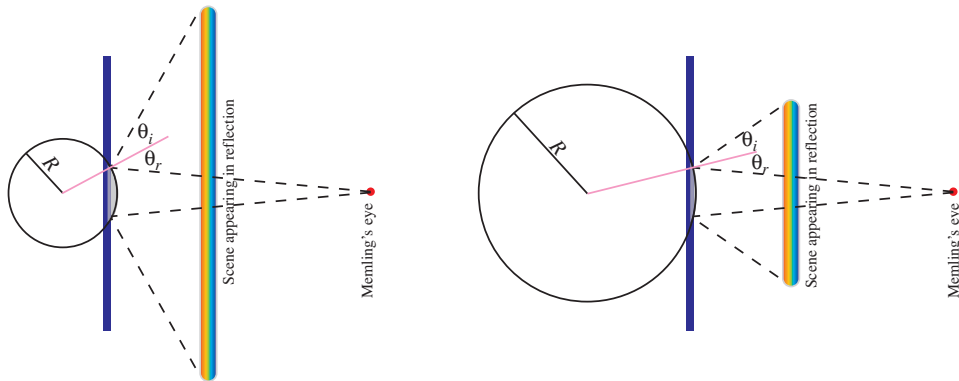


Figure 4. *Left:* A small radius of curvature, R , leads to a wide angle of view, that is, a wide angle of view in reflection. *Right:* A large radius of curvature, leads to a small angle of view, that is a narrow angle of view in reflection. Of course, the angle of incidence equals the angle of reflection, i.e., $\theta_i = \theta_r$.

We adjusted the radius of curvature curvature of the mirror to make the dewarped or rectified image as rectilinear as possible (Fig. 6). This provides the relative size of the (back) of Mary's head which in turn depends upon her distance from the mirror.

Notice in the detail of the original in the left of Fig. 7 that the reflected image does not display the warping that is most prominent around the perimeter of convex mirrors such as the van Eyck Arnolfini, the Metsys Money lender, and the Christus Saint Eligius mirrors; nor does the dark gray color of the reflected image correspond to the Virgin's red gown as it otherwise should. In short, there are strong indications that the mirror was not part of the original design, but an afterthought by the artist.

4. RESULTS

Once we had the configuration that was most commensurate with the visual information in the painting and the rules of optics, we studied the image of Mary reflected in the convex mirror and the image we would expect had Memling accurately portrayed such a tableau. First, we could rectify the image in the mirror, that is, give the

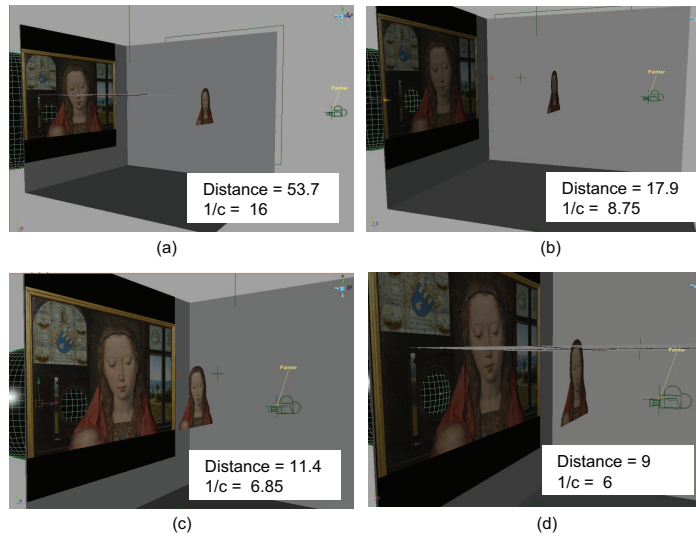


Figure 5. We adjusted the relative positions and sizes of objects to create different configurations of the scene; four are shown here. Numerical values of distance and curvature are represented in *Maya* standard units. Notice that all these quantities can be expressed only up to an unknown scale. We found that the one that best matched the image data (the distortion in the convex mirror and the relative sizes of objects and positions) is configuration (d), at the lower right.



Back of the Mary (rectification of the reflected image)

Figure 6. The dewarped or rectified view, found through adjusting the radius of curvature of the virtual model mirror and additional photo-editing.

virtual view from the position of the mirror *back* into the space of the tableau. Figure 7 shows such a rectified view.

Visual inspection demonstrates that the reflection painted by the artist shows a more dramatic bending of the linear structure on the left side (Fig. 8, right column). This bend is not compatible with the best mirror curvature predicted by our analysis (Fig. 8, left column). It appears as though in the painting the artist exaggerated the curvature in order to make the bulging effect of the spherical mirror more compelling. For instance, see the line feature highlighted in red in the lower panels of Fig. 8. Other minor incompatibilities can be noticed as well. For instance, notice the amount of fore-shortening of the reflected figures—the Mary and the van Nieuwenhove on the right: the best mirror curvature predicted by our analysis would induce a higher amount of fore-shortening in the two figures than those measured in the original painting.

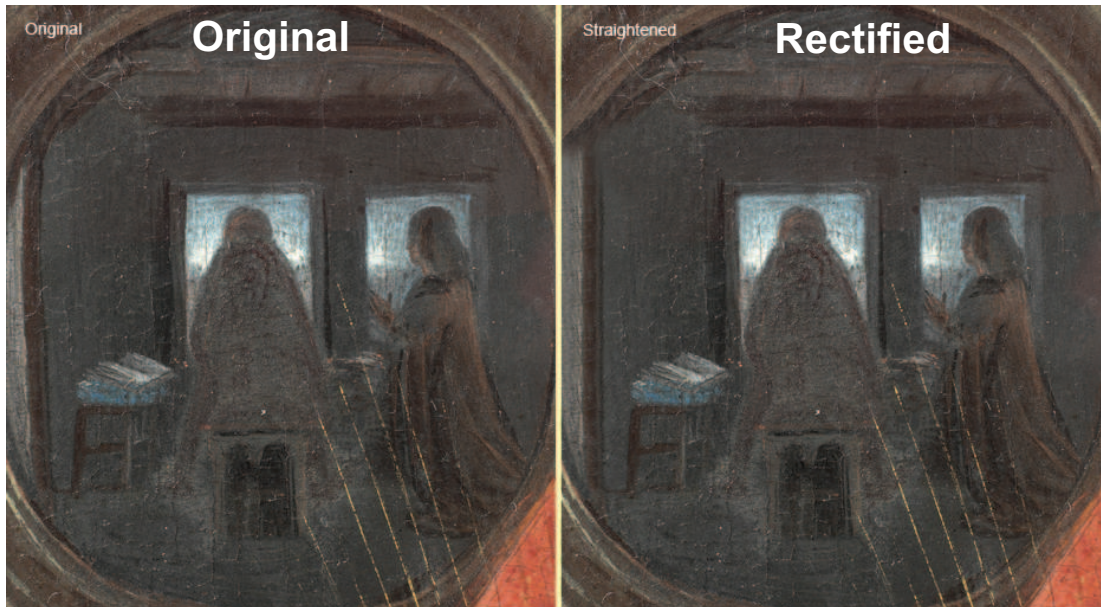


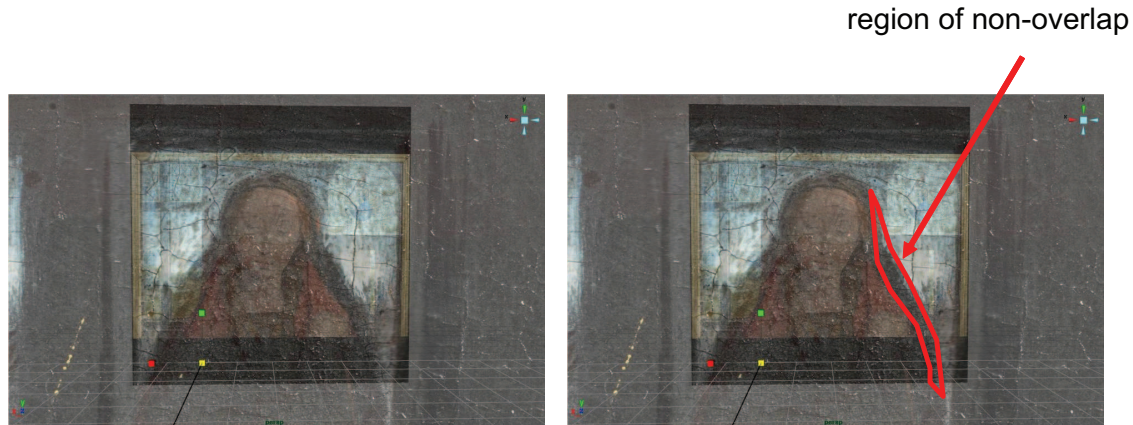
Figure 7. *Left*: Mirror in the original painting. *Right*: Original painting with rectified mirror image. Image courtesy President and Fellows, Harvard College.



Reflection induced by config. (c) Original reflection in the diptych

Figure 8. *Left column*: Image of Mary reflected in the convex mirror we would expect had Memling accurately portrayed such a tableau. Curvature and scene configuration are those of panel (c) in Fig. 5. *Right column*: Image of Mary reflected in the convex mirror in Memling’s original painting. Visual inspection shows that reflection painted by the artist exhibits a more dramatic bending of left side of the wall (e.g., notice the linear structure highlighted in red in the right-bottom panel). This bend is not compatible with the best mirror curvature predicted by our analysis. Notice the lower curvature of the same linear structure highlighted in red in the left-bottom panel.

Specifically, the rectified reflected image of the Mary is not compatible with the foreground figure of the Mary. Figure 9 shows the rectified reflected image of the Mary. If we overlay it with the foreground image of the Mary, we notice that the two figures do not overlap perfectly; the red region in the figure is the difference. Although we do not assume that the artist would have been photographically accurate throughout a painting, the “error” in the reflected image seems too large to have arisen had Memling had the model as referent.



Overlay of the reflected image
with the image of Mary

Figure 9. Each figure shows the overlap of the rectified (and left-right reversed) reflection of Mary and the scaled direct view. The right panel highlights the difference in shape between these two images— region of non-overlapping that seems too large to have arisen if Memling had worked from an actual sitter as referent.

5. CONCLUSIONS

In conclusion, we have found two major inconsistencies or incompatibilities between the image depicted in the convex mirror and the image we would expect if the room and Mary were accurately rendered:

- curvature of the mirror and amount of distortion that reflected lines should have in order to be compatible with that curvature.
- the shape of the Mary’s figure and its reflected counterpart.

These findings are in line with the idea that the mirror was indeed an afterthought by Memling (or the patron), and that the painted reflection was most probably not painted following an actual model. We hope that our findings will aid further art historical research into the actual usage of this and other diptychs in devotional practice.

Our work extends that of Criminisi and his colleagues who opened new vistas through dewarping the reflections in convex mirrors in Renaissance art.¹ While that previous work highlighted differences between northern and Italian approaches to realism (the northern based somewhat more on close observation,¹³ the Italian based somewhat more on reasoned construction¹⁴), our work sheds light on religious praxis in the early Renaissance.

More broadly, though, our work further demonstrates that new computer methods can shed light on problems in the history of art, and are most likely to profit from collaboration between computer vision experts, deeply familiar with both the power and limitations of image algorithms, and humanistic art scholars, who understand the art historical context and questions addressed.⁶

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