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The Venus effect: people's understanding of mirror reflections in paintings

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Abstract. We propose the term 'Venus effect' for a common phenomenon in picture perception. It occurs when a picture shows an actor and a mirror that are not placed along the observer's line of sight, for instance a Venus admiring herself in a small mirror, and when the actor's reflection in the mirror is visible to the observer. In this situation, observers tend to report, incorrectly, that Venus is also seeing herself in the mirror in the same location as the observer. We discuss this using famous paintings as examples.

There are many aspects of the history of visual art that are of interest to researchers in visual perception. Probably the most famous example is the use of perspective in painting. Counterintuitively, perspective requires hard work and intellectual effort to be understood and reproduced accurately (several good accounts exist, eg Edgerton 1980; Kemp 1990; Kubovy 1986). To reproduce a complex scene on a flat surface is a great challenge, involving considerable skill on the part of the artist. Recently, we have also become more aware of the fact that artists have always been interested in exploiting what the technology of the time had to offer (eg Hockney 2001; Steadman 2001; but see Tyler 2002). For instance, a simple lens can project on a flat surface a faithful (albeit inverted and reversed) reproduction of any scene. Mirrors also have been available to artists for a long time, although their size and smoothness was very limited at the beginning (Melchior-Bonnet 2001). This poor quality may be a reason why mirrors were not very common as a subject until Cézanne (according to Gregory 1997). Although the interplay between science and art is fascinating, here we are interested in a distinction between two classes of mistakes relevant when artists reproduce mirror reflections, one of them being a psychological phenomenon. We are interested in the special case where the mirror itself has become the object of reproduction and in it we see a meta-reproduction of the subject in the painting. This special case is a challenge for the artist as the subject needs to be reproduced twice, once in front of the mirror and once in it (unlike the case, also common, where the mirror is used for a self portrait—Latto 1996).

We argue that there is a need to distinguish between two different types of mistakes: optical and psychological. The first type is the less interesting to us. It may result from a misunderstanding of the principles of reflection by the artist, by simple disregard for accurate reproduction, or quite possibly by a deliberate bending of the laws of optics for specific artistic ends. As psychologists we are intrigued by the second type of mistakes: the situations in which we as observers read the scene in a certain way, but the mirror itself is used (deliberately or not) to lead us down the wrong path. More specifically, the mirror shows us something that we accept as the view available to the actor in the scene. However, the actor has a different vantage point from us and therefore the laws of optics imply that he/she cannot be seeing what we see in the mirror. When this happens, we experience a psychological illusion as defined by Gregory (1998, chapter 10).

As a convenient collection of paintings in which a mirror is present we have taken the selection in the book *On Reflection* by J Miller (1998). This includes many beautiful illustrations of paintings with mirrors. We excluded the nine which have distortions due to convex mirrors (eg van Eyck, *The Arnolfini Portrait*, 1434), the eight which have reflections in some material other than a mirror, such as water (eg Caravaggio, *Narcissus*, c 1559 – 1600), and the twenty-three in which the reflection and the object of the reflection are not both visible (eg Degas, *At the Milliner's*, 1882). We also excluded twelve paintings which were stylised and in which the orientation of the mirror was unclear (eg Kangra School, *The Lady and the Mirror*, c 1820), leaving thirty-eight paintings which were accurately representational in style and which included mirrors and their reflections and the subjects of the reflection (these thirty-eight paintings, with dates, are listed in table 1).

Table 1. Thirty-eight paintings which include a person and an image of that person in a mirror. The asterisk indicates that a person is present as well as the person's image in the mirror, even though they are not placed along the line of sight. Therefore a large proportion of the paintings could lead to a Venus effect. All of these paintings are reproduced in Miller (1998).

Painter	Title	Date
Bedoli	*Portrait of Anna Eleonora Sanvitale*	1562
Bonnard	*Woman in Front of a Mirror*	c 1905
Brockhurst	**Adolescence*	1932
Cailebotte	*In a Café*	1880
Corinth	*Self-Portrait with Mirror*	1925
Cornelis de Man	*The Card Players*	17th century
De La Tour	*The Repentant Magdalen*	c 1640
Delft School	*An Interior, with a Woman refusing a Glass of Wine*	1660 – 1665
Dix	**Woman before a Mirror*	1921
Eckersberg	*Woman Standing in Front of the Mirror*	1841
Falck	**Old Woman at Her Toilet*	17th century
Fontainebleau	*School Woman at Her Toilet*	c 1560
Gumpp	**Self-Portrait*	1646
Holman Hunt	*The Awakening Conscience*	1853 – 1854
Ingres	*Madame Moitessier*	1856
Italian School	**Allegory of Vanity—Death Surprising a Woman*	16th century
Kersting	*Before the Mirror*	1827
Manet	*Bar at the Folies-Bergère*	1881 – 1882
McEvoy	*The Ear-Ring*	c 1911
Morisot	*The Cheval Glass*	1876
Orpen	*The Mirror*	1900
Pajou	*La Famille Pajou*	1802
Parmigianino	*The Mystic Marriage of Saint Catherine*	c 1527 – 1531
Réginier	**A Young Lady at Her Toilet*	1626
Rockwell	*Girl at the Mirror*	1954
Rockwell	**Triple Self-Portrait*	1960
Romney	*Mrs Russell and Child*	1786 – 1787
Savoldo	*Portrait of a Man*	c 1521
Schall	*Evening Toilet*	c 1785 – 1790
Stevens	*La Parisienne Japonais*	c 1872
Studio of Ribera	**A Man with a Mirror*	17th century
Ter Borch	**Woman at a Mirror*	c 1650
Titian	**Venus with a Mirror*	c 1555
Vasari	**The Toilet of Venus*	1558
Velázquez	**The Toilet of Venus*	1647 – 1651
Von Aachen	**Couple with Mirror*	c 1596
Vouet	**Allegory of Prudence*	c 1645
Waterhouse	*Destiny*	1900

With respect to the first type of mistake (optical errors), there are difficulties in always reaching a confident conclusion, mainly owing to the lack of clear perspective information about the layout of the objects and the orientation of the mirror surface. It is worth mentioning that techniques exist to compute three-dimensional models from single views and some of the results are remarkable (Criminisi et al 2000). Paintings from the Renaissance period when artists actively experimented with linear perspective, and more recent work such as that of Vermeer lend themselves to this type of analysis (Steadman 2001). Nevertheless, as a quick check for optical accuracy, the three authors of this paper independently classified all of the thirty-eight paintings and for eleven of them (29%) we agreed that there was some optical distortion. Examples of this are Bedoli's *Portrait of Anna Eleanora Sanvitale* (1562) and Manet's *Bar at the Folies-Bergère* (1881) in which the position of objects in the reflection are strangely shifted to one side. Miller himself discusses some of these cases in his book.

Size is also a likely source of problems in reproducing a reflection from memory. As Gombrich (1960, page 5) pointed out in his classic book, we see ourselves in mirrors without any conscious awareness of the size of the image on the mirror surface itself. The vast majority of us is indeed unaware that the size of our body on the surface of the mirror is unaffected by distance (and is half the physical size). In a sense, this is the reversal of size constancy: we believe our image on the surface of the mirror becomes smaller as we move away, when in fact it stays constant. A good illustration of the problem with size is discussed by Gregory (1997; see also Parks 2001). According to Gregory, the face of Venus in Velázquez's *Rokeby Venus* (1647) is "at least twice the size it should be" (Gregory 1997, page 21). The precise relationship between the head and its mirror image depends on the distance of the observer, but the gist of Gregory's observation is correct.

As we said earlier, even when optical mistakes in paintings can be identified, they are not the primary interest of this paper. After all, many other aspects of the paintings could be criticised in this rather prosaic fashion. For instance, it is not unusual for multiple vanishing points to be present, even in paintings by masters such as Giotto, Donatello, Masolino, Dürer, and others (Kemp 1990). Another reason is that, in general, artists are not interested in reproducing reality. Rather they are interested in the pictorial images themselves (although Leonardo da Vinci was famously dissatisfied with the limitations of a canvas to match the reality of a mirror reflection). We turn now to the second type of mistakes, which are psychological in nature and which we call the Venus effect.

Of the thirty-eight paintings in Miller's *On Reflection* (1998), our independent classification found fourteen (37%) which had a person (most often a woman, such as Venus) apparently looking at herself in a small mirror, but with the disposition of the scene such that, in fact, we (the viewers) see her in the mirror from a different vantage point. This is indicated by an asterisk in table 1. Often someone is attending to Venus and orienting a mirror, as in Vasari's *The Toilet of Venus* (1558) or Velázquez's *Rokeby Venus* (1647), so that there is no doubt that the mirror is being used for grooming or other narcissistic purposes. The problem is that the vantage point from which the scene is represented (as well as the vantage point of the viewer, were they to differ) is different from the vantage point of Venus. Therefore, if we see Venus's face nicely framed inside the mirror, she must see something quite different. If the painter reproduced what he saw, then the model must have seen the painter in the mirror. This is far from optically impossible (depending on the exact orientation of the mirror), and therefore the only problem is with the psychological illusion that we experience in reading what we see. Most of us accept that Venus is seeing herself in the mirror. In the National Gallery in London, where the *Rokeby Venus* is housed, this Venus illusion is noted and discussed in the catalogue (Baker and Henry 2001). Therefore we do not claim the

absolute novelty of our observation. Nevertheless, to the best of our knowledge this eminently psychological effect has not been discussed in the psychological literature. Incidentally, the website of the National Gallery has a much more ambiguous and paradoxical description of the *Rokeby Venus*: "She is shown here with her son Cupid, who holds up a mirror for her to look *both at herself and at the viewer*" (italicising is ours) (National Gallery London 2002).

A definition of the Venus effect can be given as follows: The Venus effect occurs every time the observer sees both an actor (eg Venus) and a mirror, not placed along the observer's line of sight, and concludes that Venus is seeing her reflection at the same location in the mirror that the observer is seeing. Figure 1 shows what happens when the observer and Venus are offset. In figure 1 Venus is placed in front of a mirror. This is necessary for her to see her face centred in the mirror (independently of the orientation of her head). If the observer moves from right to left he/she will start seeing Venus's left ear at position A and Venus's right ear at position B. Therefore only after the observer has moved beyond position B can he/she see the full face of Venus. The offset clearly depends on the distances between the items and also on the size of the mirror, but the reader can extrapolate the effect of these variables from figure 1. Note that we have used a relatively large mirror in this diagram, compared with what Venus is likely to use (see figure 2). The important point is that when an offset is present, the observer and Venus must have a similar vantage point if they are to share a similar view in the mirror.

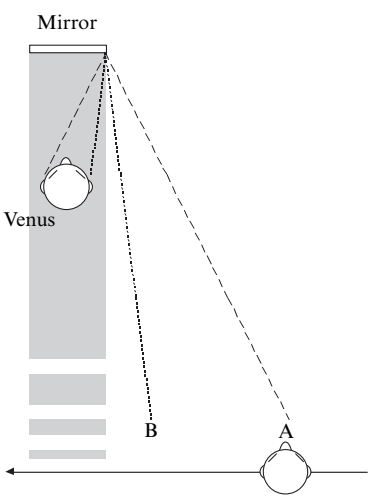

Figure 1. The diagram represents Venus in front of a mirror. Venus can see the reflection of her own face in the centre of the mirror. Venus's head orientation is irrelevant as long as she can turn her eyes to look at the mirror. Outside the gray area, Venus could not see herself at all. Imagine observers moving from right to left. At position A they will start seeing Venus's left ear, but only at position B will they see the right ear and therefore the full face (albeit not yet centred in the mirror). The reader can extrapolate the lines for different positions of the observer. The size of the mirror is also an important factor, as smaller mirrors constrain the alignment more than larger ones.

To confirm that most people read these paintings as we have suggested, we asked twelve naïve observers to describe the scene in the *Rokeby Venus* (as well as a second painting as a decoy). Nine (75%) volunteered the description that Venus is looking at herself in the mirror. Interestingly, this description also matches the first documented description of the painting in the collection of Marqués del Carpio in 1651.

In more formal experiments, Croucher et al (2002) have recently found that a large proportion of adults hold mistaken beliefs about what is made visible by a mirror. For example, they expect to be able to see their own reflections before they arrive in front of a flat mirror. Moreover, Bertamini et al (2003) have also found a high degree of tolerance when people were asked to judge the naturalness of correct or distorted mirror reflections. These types of problems in reasoning (and perceptual judgments) about mirrors are consistent with the fact that the Venus effect that we have described above in famous paintings has gone largely unnoticed. For example, although Miller (1998) presents a number of paintings with flat mirrors and accurate perspective in which

Figure 2. Left: Vasari *Toilet of Venus* (1558, Stuttgart, Staatgalerie). Middle: Hans von Aachen *Couple with Mirror* (c 1596, Vienna, Kunsthistorisches Museum). Right: Simon Vouet *Toilet of Venus* (c 1628, Cincinnati, Cincinnati Art Museum). Notice how the face of the woman is seen in opposite profile, full face, and same profile, respectively, despite the similar layout. A colour version of this figure can be viewed on the *Perception* website at http://www.perceptionweb.com/misc/p3418/. Images reproduced with permission, copyright Staatsgalerie Stuttgart, Kunsthistorisches Museum Wien, and Cincinnati Art Museum, respectively.

subject and reflection are both present, and discusses each in great detail, 37% of these paintings include this psychological effect, without it being mentioned in the book.

As an illustration of the Venus effect, figure 2 presents three paintings from the 16th and 17th centuries (albeit from different schools): Vasari's *Toilet of Venus* (c 1558), Hans von Aachen's *Couple with Mirror* (c 1596), and Simon Vouet's *Toilet of Venus* (c 1628) (the first two are also reproduced in Miller's book). It is difficult to establish the exact angle of orientation of the mirror surface, although in von Aachen's case it seems to be almost orthogonal to our line of sight. Nevertheless with respect to the Venus effect we only have to judge whether the mirror and Venus are aligned. They clearly are not. They are, instead, roughly side-by-side from the vantage point from which we are looking at the scene.

Moving beyond the Venus effect, let us consider the possibility that these depictions are compatible with a scene in which Venus is not seeing herself in the mirror. In figure 1, we have started from the assumption that Venus is looking at herself and placed the mirror accordingly. If we accept that Venus may be seeing something else in the mirror, then a larger number of possibilities arise. For instance, the mirror may be placed at exactly the right angle for the observer to see Venus's face. This possibility raises another question: in the three example we see similar layouts but very different images of Venus's face in the mirror: from straight-on (von Aachen's *Couple with Mirror*) to a profile in the same orientation as Venus's profile (Vouet's *Toilet of Venus*), to the profile in the opposite orientation (Vasari's *Toilet of Venus*). Uncertainties about the shape and exact position of the mirrors constrain the analysis, but at least for the reverse profile in the Vasari we can say that the mirror would have to be placed much closer to the observer (away from Venus) for this to be possible. If the mirror is farther than the face, we would see the opposite side of the face (the other cheek), whereas we need to see the same cheek for the two faces to point in opposite directions. As we said before, we are not particularly interested in finding optical mistakes, but we would like to suggest that something clever about what the painters have done is emerging here. It seems to us that they have captured very well the psychology of seeing ourselves in a mirror. As we look at ourselves facing a mirror, the virtual person is always looking back at us (if our nose is due North, the virtual nose is due South). Maybe that is why in Vasari's *Toilet of Venus* the face in the mirror looks back to Venus and their noses point at each other. Similarly, in von Aachen's *Couple with Mirror* the woman is looking roughly straight ahead, but the virtual woman has to turn her eyes all the way to the left to look back at her real self.

Incidentally, to many observers there is something odd about the mirror image in Vasari's painting, although it is hard to say what it is. The catalogue of the Stuttgart museum does ask the question whether the person in the mirror is the same as Venus, since it seems to have a masculine appearance (Stuttgart Staatsgalerie 2002).

An analogy can be made between the Venus effect and Kubovy's (1986) argument about the role of the viewer in the case of perspective. He argues that, when a picture is perceived from a vantage point other than the centre of projection, our perceptual system infers the location of the centre of projection and we feel that we are looking at the picture from that vantage point. One of the examples he discusses is Paolo Uccello's *Sir John Hawkwood* (1436) in which two very different vantage points are combined. Not everybody agrees with this hypothesis, but if it is true that we are able to read multiple vantage points, maybe something similar happens in the Venus effect. We see Venus from one vantage point, but we see the reflection from a different one, namely with the eyes of Venus herself. Speaking more generally, there is nothing new in the idea that in picture perception observers may display the same abilities that they need to deal with "a world that is ambiguous and incomplete *in each momentary glance*" (Hochberg 1980, page 60).

The Venus effect is also exploited routinely in television and film production. It would be hard for the camera to show a satisfactory scene with both the actor and the image of the actor in the mirror when the actor is actually looking at his/her own image. However, it is very easy to place the actor in a position where the camera can see both the actor and the reflection of the actor's face. The only problem is that the actor must now see the camera in the mirror. Thankfully, most viewers will be completely unaware of the fact that the actor is not looking at himself/herself and will read the scene as one where the actor is reviewing the self-image in the mirror. A good illustration of this can be found in Miller's book, in the reproduction of a still image from *Snow White and the Three Clowns* (Twentieth Century Fox, 1961), but countless examples can be easily found by the reader at the cinema or on television.

In conclusion, in our experimental work (Croucher et al 2002; Bertamini et al 2003) we found widespread misconceptions about the optics of mirror reflections in the general population. The present discussion of some reproductions of mirrors in art shows that compatible evidence can be found in the way we view paintings. In other words, even though we do not want to infer much about the artists' intentions or knowledge of optics, we can observe considerable tolerance in how people, including psychologists, interpret the behaviour of the mirror.

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