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Picture Perception and the Two Visual Subsystems

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Abstract

I aim to give a new account of picture perception: of the way our visual system functions when we see something in a picture. My argument relies on the functional distinction between the ventral and dorsal visual subsystems. I propose that it is constitutive of picture perception that our ventral subsystem attributes properties to the scene, whereas our dorsal subsystem attributes properties to the surface.

Keywords: picture perception; dorsal subsystem; ventral subsystem

Introduction

How does our perceptual system function when we see a depicted object in a picture? What makes it possible that we have this ‘seeing-in’ experience? Ernst Gombrich claims that when we see something in a picture, our attention alternates between the two dimensional surface and the three dimensional represented object (Gombrich 1960). Richard Wollheim, in contrast, argues that the experience we are supposed to go through when looking at pictures is a twofold one: we are simultaneously aware of the picture surface and the represented object (Wollheim, 1980; 1987; 1998, Nanay, 2004; 2005).

This feature of our experience of pictures is called ‘twofoldness’ and in some form or other, many accounts of depiction endorsed it as a necessary feature of our experience of seeing something in a picture: if our experience is not twofold, then we may see the surface or the depicted object, but we cannot see the depicted object in the picture. But neither Wollheim nor other philosophical accounts of pictorial perception say much about what is supposed to be meant by the twofoldness of experience. My aim in this paper is to give a model of how we perceive pictures and, as we shall see, this model will be consistent with the Wollheimian notion of twofoldness.

A very important caveat: it has been pointed out that Wollheim’s notion of twofoldness is ambiguous (Nanay, 2005). On the one hand, it is taken to be a necessary condition for perceiving pictures. On the other hand, it is sometimes also taken to be a necessary condition for the aesthetic appreciation of pictures, a very different notion indeed (Nanay, 2005 gives a detailed analysis of when Wollheim uses the former notion and when he uses the latter one. This paper is not an exegesis of Wollheim’s arguments and terminology; I am interested in the experience that constitutes seeing objects in pictures and I will use the term ‘twofoldness’ to refer to the feature of our experience that Wollheim describes as necessary for seeing-in (regardless of

whatever else he says about the aesthetic appreciation of pictures).

Picture perception and the two visual subsystems

Humans (and other mammals) have two visual subsystems that use different regions of our central nervous system, the ventral and dorsal streams. To put it very simply, the ventral stream is responsible for identification and recognition, whereas the function of the dorsal stream is the visual control of our motor actions. In normal circumstances, these two systems co-function, but experiments show that if one of them is removed or malfunctioning, the other can still function relatively well (see Milner&Goodale, 1995; Goodale&Milner, 2004, for overview. It is worth noting that the dorsal-ventral distinction is not really clear-cut as the two subsystems interact at various points (Goodale&Westwood, 2004).

If the dorsal stream is malfunctioning, the agent can recognize the objects in front of her, but she is incapable of manipulating them or even localizing them in her egocentric space. This happens if a patient is suffering *optic ataxia*. If the ventral stream is malfunctioning, the agent can perform actions with objects in front of her relatively well, but she is incapable of even guessing what these objects are or telling where they are. This happens in the case of *visual agnosia*.

Under exceptional circumstances, the ventral visual subsystem of healthy humans attributes a different property to an object from the one the dorsal subsystem does. In the case of the three dimensional Ebbinghaus illusion, although our judgment of the comparative size of two chips is wrong, if we are asked to pick up one of the chips, our grip-size is not influenced by the illusion (Aglioti et al., 1995). In the case of the Müller-Lyer illusion, while we (mistakenly) see the two lines as having different length, our eye- and pointing movements represent them (correctly) as being the same (Goodale&Humphrey, 1998; Bruno, 2001).

My claim is that our visual system functions in a somewhat similar manner when we are perceiving pictures. I will argue that the dorsal and the ventral visual subsystems attribute different properties to the perceived object whenever we see objects in pictures. The ventral subsystem attributes properties to the depicted scene whereas the dorsal subsystem attributes properties to the surface of the pictures.

Or, to put it very simply, it is constitutive of our experience of seeing things in pictures that the depicted scene is represented by our ventral vision, whereas the surface of the picture is represented by our dorsal vision. Although this latter formulation is simpler, it is also slightly

ambiguous. I intend to spell out the ambiguity in order to be able to use this simple way of characterizing the main claim of this paper.

Some depicted objects do not exist. As a result, according to most philosophical analyses of perception, we do not literally perceive these objects. This is a complex question and I do not need to engage with it here. What is important for our purposes is that even if we do not (literally) perceive depicted objects, we are in perceptual states that represent these objects (whether or not they exist) as having certain properties. To sum up, the ventral subsystem represents the depicted scene (whether or not it exists) as having certain properties, whereas the dorsal subsystem represents the picture surface as having certain properties.

The argument

I need to argue for four claims in order to show that the ventral subsystem represents properties of the scene, whereas the dorsal one represents properties of the surface:

- (a) The depicted object is represented by ventral perception
- (b) The depicted object is not represented by dorsal perception
- (c) The surface is represented by dorsal perception
- (d) The surface is not necessarily represented by ventral perception

I will address these claims in turn.

(a) The depicted object is represented by ventral perception

I take this claim to be the least controversial of the four. When we look at pictures, we can recognize what they are of. This is the reason why we can learn about something by looking at its pictorial reproduction (Matthen, 2005, p. 308). Apparently, even chimpanzees are capable of this (Tanaka, 2007).

Some empirical support for this claim is provided by the fact that patients suffering visual agnosia are incapable of seeing objects in pictures (Westwood et al., 2002). These patients have a functioning dorsal stream but there are serious impairments in the ventral stream. D. M., one such patient, can copy the two dimensional lines of a picture but she cannot tell whether these two dimensional lines depict an impossible object. Further, she is not subject to optical illusions (Müller Lyer, Ponzo) that are usually taken to presuppose our ability to see three dimensional objects in two dimensional figures (Turnbull et al., 2004).

(b) The depicted object is not represented by dorsal perception

The main claim of this sub-section is that depicted objects are not represented by dorsal perception (though, as we shall

see, it may be represented by ventral perception).¹ Dorsal perception is what allows us to localize objects in our egocentric space and helps us perform actions with them. As the space of the picture is not our egocentric space, we cannot localize the depicted objects (that are in the space of the picture) in our egocentric space. As Matthen argues, “a picture gives you no information of the location relative to yourself. Suppose you are looking at a picture of two men shaking hands. *Where* are they? As far as what you can tell by seeing in the picture, the question has no answer” (Matthen 2005, p. 315).

Some further care is needed to make this point. How should we interpret what is meant by ‘the ability to localize an object in one’s egocentric space’?

One possibility would be to say that this ability is just the ability to interact with this object. This is, for example, the way Gareth Evans understood egocentric space, as he argued that egocentric space is action space (Evans, 1982). If we accept this interpretation of the ability to localize objects in one’s egocentric space, then we have a neat argument for (b). We cannot touch, smell or grasp the depicted objects: we cannot perform actions with them. We can touch, smell or grasp the part of the surface that represents these objects, but not the depicted objects themselves. Thus, as dorsal vision is what allows us to perform perceptually guided actions, the depicted objects are not represented dorsally (Matthen, 2005, p. 312).

However, if we accept this interpretation of localization in one’s egocentric space, then we are in danger of concluding that the perception of depicted objects and the perception of distal objects is analogous. This may or may be an intuitively plausible claim; Matthen, 2005, pp. 322-323 happily endorses it, for example. But it is much less clear that we have any empirical evidence that distal objects do not engage our dorsal vision. A further possible worry about this interpretation is that there are scenarios where we see objects in pictures and we also interact with them. When a surgeon is performing an operation on a surface she can only see through the display of a monitor, this may be an instance of seeing an object in a picture and physically interacting with it. Note that she could not perform this operation without perceiving objects on the monitor: what she sees on the monitor guides her action: thus, it needs to be represented dorsally. Thus, in this case at least, the argument for (b) does not seem to go through.

Thus, I would like to appeal to another notion of localization in one’s egocentric space that is less problematic. It is not necessary for having the ability of localizing an object in one’s egocentric space that one can manipulate this object physically. If I see an apple in a thick plexy-glass container in front of me, I cannot touch it or grasp it; still, I can localize it in my egocentric space. What

¹ It is important to emphasize that we can perceive depicted objects as affording actions for someone who is also depicted in the picture (for example, if we watch a sport event on television. But this does not mean that the depicted objects are represented dorsally.

is, however, necessary for having the ability to localize an object in one's egocentric space, is that the agent represents the distance between the object and herself in some (not necessarily conscious or explicit) way. Thus, if I can localize an apple in my egocentric space, then if I move towards it (and the object itself does not move) than I should expect that the object will be closer to me than before (this ability is sometimes referred to as 'sensorimotor skill', see Noë, 2004; Campbell, in press).

Even if we accept this weaker notion of what it means to be able to localize an object in one's egocentric space, we can still establish (b). If we move towards the direction of a depicted apple, we do not thereby move closer to the apple: we move closer to the picture surface, but not the apple.

It is also worth noting that according to this notion of egocentric space, the surgeon does not localize what she sees on the monitor (including her own hand) in her egocentric space. Thus, this potential counterexample to (b) is no longer a counterexample if we accept the way of thinking about egocentricity I suggested.²

(c) The surface of the picture is represented by dorsal perception

Matthen claims that the surface *can* be represented by dorsal perception, but he does not make the stronger claim that the surface *must* be represented by dorsal perception in order for us to be able to see objects in this surface (Matthen said that he would be open to such claim though – personal communication, June 2007). I will argue for this stronger claim.

Suppose I am looking at a postcard. If someone asks me to touch the surface of the picture, I would have no problem doing so. If someone asked me to move in such a way that I see the postcard head on, I can do that easily. As dorsal perception is supposed to guide these actions, it seems that we must represent the surface dorsally. But let us proceed more slowly.

It is not a particularly controversial claim that we visually represent the surface when we recognise the depicted object in a picture. It has been shown that our judgment of the size of perceived object is different if these objects are depicted (even in a hyper-realistic way) from our judgment when we see these objects through a glass, screen or colored glass. This phenomenon is taken to demonstrate that we represent the surface of the picture perceptually (see Hagen et al., 1978).

² It has been argued that instead of two visual subsystems, we need to talk about three: the ventral, the ventrodorsal and the dorsodorsal. Thus, what has been taken to be one single dorsal subsystem should be divided into two: one responsible for manipulating objects (dorsodorsal) and one responsible for localizing in egocentric space (ventrodorsal) (Rizzolatti & Matelli, 2003). My strategy was to show that we do not localize depicted objects in our egocentric space. Thus, the argument I presented in this section, rephrased using the terminology of the three visual subsystems framework, aimed to show that our *ventrodorsal visual subsystem* does not represent the depicted object.

There are, of course, occasions where we are not aware of the picture surface: we have no idea how far away it is from us and if we had to touch it, we would be at a loss. Taking aside the various anecdotes of insects that tried to fly through the canvas of a still-life, the obvious examples are *trompe l'oeil* paintings. If we are genuinely fooled by the *trompe l'oeil*, then we would readily try to reach through the canvas – we would not be aware of the surface. It is a controversial question whether *trompe l'oeil* paintings count as genuine instances of depiction (Wollheim, 1987; 1998, Levinson, 1998). Whether or not they do, seeing *trompe l'oeil* paintings (that is, being fooled by them, see Lopes, 2005 for a detailed analysis of our experience of *trompe l'oeil* paintings) is not a twofold experience, as we are supposed to be unaware of the fact that it is a picture at all that we are looking at.

The controversial question is, of course, in what way we represent the surface: ventrally or dorsally? In order to settle this question, I would like to appeal to a very widely discussed phenomenon in connection with picture perception.

The phenomenon is that if our position changes in front of the picture, our view of the depicted object does not change (Vishwanath et al., 2005; Pirenne, 1970; Wollheim, 1980, pp. 215-216; Matthen, 2005, pp. 315-317). Even if we look at a picture from an oblique angle, we don't see it as distorted. This suggests that we are perceptually aware of the orientation of the picture surface and this awareness compensates for the oblique view: that is why we do not see the depicted object as distorted (Pirenne, 1970).

What is interesting from our point of view is that there are cases where there is no such compensation. When we are looking at ceiling frescos from an oblique angle, for example, we do see the depicted scene as distorted. So what is the difference? Pirenne's original suggestion is that we do not have perceptual access to the orientation of the surface of the fresco, because it is too far away. When (because of the crowd) we are looking at the Mona Lisa from an oblique angle, however, we do have perceptual access to the orientation of the picture surface, which allows our perceptual system to compensate for the oblique view: our experience of the depicted scene is not distorted.

So far, I pretended that Pirenne's analysis of the 'compensation' for the oblique point of view is uncontroversial. It is not. If Pirenne were right, then perceptual access to the orientation of the surface would be necessary and sufficient for compensating for the oblique angle and thus, for not experiencing the depicted scene in a distorted manner. But both the necessity and the sufficiency claims have been questioned. It seems that even if all the cues that indicate the orientation of the picture surface are artificially removed, we still experience the depicted scene without any distortions (Busey et al., 1990). Further, it has also been argued that even if we do have cues that indicate the orientation of the picture surface, we sometimes do experience a distorted depicted scene (Halloran, 1989). It needs to be noted that these two experiments are not

considered conclusive (see Rogers, 1995; Kulvicki, 2006), but they at least challenged the general acceptance of the ‘compensation’ view. As Koenderink et al. 2004, p. 526 says, “there appears to be some (weak) consensus that no ‘correction’ is applied to pictorial space due to obliquely viewed pictures”.

But the ‘compensation’ view, and the possibility of explaining what we experience when we look at pictures from an oblique angle, could be salvaged if we introduce a distinction between having ventral perceptual access to the orientation of the picture surface and having dorsal perceptual access to it. The arguments, pro and contra, on compensation of oblique angle that I quoted in the last paragraph seem to assume that our ‘access to the orientation of the picture surface’ is ventral awareness. In the experiment, for example, that is supposed to show that we do ‘compensate’ even without perceptual cues about the orientation of the picture surface, these cues are cues that are ventrally represented (the ‘double projection technique’ that Busey et al., 1990 use for removing these cues would remove ventral cues only). Thus, what this experiment really shows is that our ventral perceptual access to the orientation of the picture surface is not necessary for experiencing the depicted scene without any distortion.

My proposal is that we should interpret our perceptual access to the orientation of the picture surface as a dorsal phenomenon: if we do so, we do not face any of the objections outlined above and we can indeed use Pirenne’s original observations to explain what we experience when we look at pictures from an oblique angle. And some recent studies seem to support this hypothesis. In a recent article, Vishwanath et al., 2005 argued for a version of the ‘compensation’ view, where they describe our perceptual access to the orientation of the picture surface as ‘task-dependent’ ‘local slant’. Both task-dependence and locality are dorsal features.

To sum up, it seems that if we interpret our perceptual access to the orientation of the picture surface as a ventral phenomenon, then it fails to account for the phenomenon that we experience depicted scenes without distortions even if we look at the picture from an oblique angle. But if we interpret this perceptual access as a dorsal phenomenon, then we can indeed explain this puzzling phenomenon. To go back to Pirenne’s original fresco example, when we are looking at a ceiling fresco from an angle, what we are lacking is dorsal access to the orientation of the fresco – the fresco is too far away for our dorsal subsystem to allow localization in our (egocentric) space. Thus, we have good reason to suppose that our perceptual access to the orientation of the picture surface is dorsal and this is exactly what we need in order to support claim (c): the picture surface is represented not by the ventral but by the dorsal subsystem.

(d) The surface of the picture is not necessarily represented by ventral perception

It is crucial to note that the scope of this claim is different from that of the previous three. I will not argue that the

surface is never represented by ventral perception, but only that it is not necessary for seeing-in that we represent the surface ventrally.

The main argument here is that we do not need to recognize the surface features in order to see an object in the picture. We do not need to be able to recognize the ellipsoid shape on the surface to see a round coin in the picture. And most of the time we do not do so. When I am watching a football game, I do not need to recognize a trapezoid shape on the screen in order to see the goal. It seems that most of the time when we see things in pictures, we can do so without recognizing any of the surface features – without representing the surface ventrally.

But there are cases where we might do just this, especially if we are interested in the way the coin (or the goal) is depicted. In this case, our attention may be drawn to some of the features of the surface: brushstrokes, composition, and so on. My point is that this is not necessary for seeing things in pictures. We can see an apple in a picture even if we cannot recognize, thus, ventrally represent any features of the surface.

It is an extremely interesting question *when* we represent surface features ventrally and the answer to this question may be a step towards understanding not seeing-in, but the aesthetic appreciation of pictures or what is known in the depiction literature as ‘inflection’: the phenomenon that our perception of the depicted object is ‘inflected’ by the fact that it is depicted (Podro, 1991, p. 173; 1998, p. 28; Lopes, 2005 p. 40, pp. 128-9; Hopkins, ms). It has been suggested that (ventral) attention to the picture surface is necessary for inflection and thus, for the aesthetic appreciation of pictures (Podro, 1991; Lopes, 2005, and arguably (see Nanay, 2005) this is also Wollheim’s view in Wollheim, 1980; 1987). But as it has been pointed out (Levinson, 1998; Lopes, 1996, pp. 37-51), the aesthetic appreciation of pictures is not necessary for seeing-in. To put these two claims together: (i) (ventral) attention to the surface is necessary for the aesthetic appreciation of pictures, (ii) the aesthetic appreciation of pictures is not necessary for seeing-in. Thus, (ventral) attention to the surface is not necessary for seeing-in, which is exactly what we need to establish claim (d). Even if it is a necessary condition for the aesthetic appreciation of pictures that the surface engages our ventral vision, this claim should not be extended to seeing-in in general.

Two objections

I need to address two possible objections that could jeopardize the account of picture perception I put forward.

First, how would my account explain the fact that we can perceive pictures of pictures? I have argued (see (b) above) that our dorsal vision does not attribute properties to depicted objects. But then our dorsal vision cannot attribute properties to the surface of the depicted picture either. But as (see (c)) it is necessary for seeing things in pictures that our dorsal vision attributes properties to the picture surface,

we cannot see anything in the depicted picture. But this does not sound right.

To put it briefly, suppose that I am looking at a picture A that depicts another picture B depicting object C. Because of (b), I cannot perceive the surface of B dorsally. But because of (c), I need to perceive the surface of B dorsally in order to see C in B. Thus, I cannot see C in B.³

My response is to bite the bullet. We do not see anything in a depicted picture: we do not see C in B. We do see C in A, the picture we are looking at, and whose surface we do perceive dorsally. And we do see B in A. We see a picture (B) in A and we see the object depicted by this picture B in A, but we do not see C in B. Consider the painting on the wall of the room in Vermeer's *Woman holding a balance*. It depicts the Last Judgment. My claim is that we do not see the Last Judgment in the picture on the wall of the woman's room. We do see a painting on the wall of the woman's room in the Vermeer painting and we do see the Last Judgment in the Vermeer painting.

If we want to adjudicate between my explanation of seeing pictures in pictures and the one that is supposed to be problematic for my account, according to which we see things in depicted pictures, we need to decide whether we see things in the depicted picture (on the wall in Vermeer's painting) or in the picture we are looking at (the Vermeer painting itself). I will argue that we have good reason to believe that it's the latter.

Consider the perception of pictures in pictures where a picture is depicted from an oblique angle. Our estimation of the spatial relations of the objects depicted by the depicted picture is notoriously wrong. And our estimation of the spatial relations of objects depicted by a picture viewed from the same oblique angle is not (Vishwanath et al., 2005; cf. Koenderink et al., 2004).

Take Canaletto's *Grand Canal looking South-east*. There is a larger building on the right hand side of the Canal. If we look at this picture face to face, even from a very oblique angle, we have no problem identifying what building on the left hand side of the Canal would be opposite this large building. If, however, we look at a high resolution photograph of this painting from an oblique angle, it is extremely difficult to tell, which building on the left hand side of the Canal is the one that would be opposite the large building on the right (see also Sedgwick & Nicholls, 1993).

We do not perceive the surface of the painting dorsally. Thus, my account predicts that we cannot see objects in this painting in the same way as we would if it were in front of us so that we could perceive its surface dorsally. And this is exactly what we experience: the way we see objects in surfaces that we do not perceive dorsally is distorted. The way we see objects in surfaces that we do perceive dorsally

is not distorted even if we look at these pictures from an oblique angle.

Thus, we see the (distorted) Grand Canal in the photograph and we see the painting in the photograph. We do not see the (distorted) Grand Canal in the painting. The 'pictures of pictures' objection is avoided.

The second possible objection is the following. I argued that both the ventral and the dorsal subsystems are needed for the perception of objects in pictures. There may be some empirical worries about this claim. It seems consistent with the empirical literature that the ventral subsystem is needed for picture perception as it has been shown that the breakdown of the ventral stream (as we have seen in the case of D. M., the patient with visual agnosia) leads to a breakdown in picture perception. So far so good.

But what happens if the dorsal stream breaks down? As in my account both the ventral and the dorsal subsystems are needed for picture perception, one could argue that if my account is correct, then, we should expect somewhat impaired picture perception among optic ataxia, that is, if it is not the ventral but the dorsal stream that breaks down. The picture perception of patients with optic ataxia has not been tested but researchers who work with such patients would not exclude the possibility that they can indeed see objects in pictures (David Milner, personal communication, June 2007, Christopher Striemer, personal communication, June 2007). If this turned out to be the case, would this jeopardize my account?

I don't think it would. Patients with optic ataxia tend to cope well with their environment, the lack of the dorsal stream is only manifest under some special circumstances. For example, they have no problem reaching for and grasping objects in their fovea, difficulties with manipulation only occur if they perceive something outside of their fovea. Also, as these patients have been growing up in a world full of pictures, it seems unlikely that they wouldn't acquire a non-dorsal way of recognizing *that* they perceive a picture. And maybe their way of relating to pictures is based not on seeing-in, but on the ventral recognition *that* they perceive pictures. More experiments need to be conducted on this, but for now it is sufficient to point out that if optic ataxia patients have problems with their picture perception, this would confirm my account, but if they don't, this would not falsify it.⁴

³ It is important to note that this problem does not arise if the surface of A is the same as that of B, as they most often are when we look at reproductions of paintings. I will take it for granted in what follows that the two surfaces are different and distinguishable.

⁴ It is also possible that the way patients with optic ataxia perceive pictures is similar to the way we perceive pictures depicted by another picture: we do not see objects in them. They see the depicted object, they see the picture surface and they infer that this object is depicted by this picture. Yet, they don't see the object *in the picture*. This hypothesis could also be tested by examining whether optical ataxia patients misestimate the spatial relations between the depicted objects in a picture viewed from an oblique angle.

Conclusion: Twofoldness revisited

I argued that it is necessary for picture perception that our ventral vision attributes properties to the depicted object, whereas our dorsal vision attributes properties to the picture surface. And these separate perceptual processes constitute the two folds of our twofold experience of pictures.

Wollheim stated that the twofoldness of our experience is a necessary condition for representational seeing or seeing-in. This suggestion has often been dismissed and criticised for its obscurity. I argued that there is a straightforward and empirically plausible way of filling in the details of Wollheim's notion of twofoldness that would preserve the spirit of the original notion but would also make it testable and, therefore, falsifiable.

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