

Three Varieties of Visual Field

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Abstract

The goal of this paper is to challenge the rather insouciant attitude that many investigators seem to adopt when they go about describing the items and events in their "visual fields". There are at least three distinct categories of interpretation of what these reports might mean, and only under one of those categories do those reports have anything resembling an observational character. The others demand substantive revisions in one's beliefs about what one sees. The ur-concept of a "visual field" is that of the "sum of things seen", but one can interpret the latter in very different ways. The first is the "field of view", or the sum of physical things seen. The second is an array of visual impressions, whose spatial relations are distinct from those of physical phenomena in front of the eyes. The third is an intentional object: the world as it is represented visually. These three categories are described, and various locutions of vision science--such as "optic array", "retinocentric space", "visual geometry", "virtual object" and others--are analyzed and variously located within them. Finally, a recent argument purporting to necessitate the existence of a version two visual field is examined and shown wanting.

Reports of items and events in the "visual field" are all too often issued as if they are commonplace observations--descriptions of things right in front of the eyes, in plain view of everyone, which any honest investigator must acknowledge. This feature of the reports is puzzling and worrisome, since typically it emerges that the "visual field" is not something literally in front of the eyes at all. Most often this "field" is one whose borders do not abut any property lines located within physical space. Alternatively it is construed as a stage of sensory processing, located behind the eyes somewhere, in the nervous system. In either case, any honest investigator, asked to acknowledge a description of the occupants of the "visual field", should worry over the answer.

A recent locus for these worries is found in a brief passage in an article by Paul Boghossian and David Velleman in *Mind* (1989). In that passage they argue that after-images and double images have locations distinct

from those of the distal objects in front of the eyes, and that such locations oblige us to postulate a visual field in which those images can reside. I will use this passage as a stalking-horse for this paper, and I hope to show that this argument does not succeed. But more importantly the exercise will yield three different accounts of what people might mean when they talk about their visual fields: three different varieties of phenomena with which an organism might be outfitted. Here is what Boghossian and Velleman say:

Consider ... an experience, in which an after-image appears to you *as* an after-image--say, as a red spot obscuring the face of a person who has just taken your photograph. Since you suffer no illusion about the nature of this spot, you do not see it as something actually existing in front of the photographer's face. In what sense, then, do you see it as occupying that location at all? The answer is that you see it as merely appearing in that location: you see it as a spot that appears in front of the photographer's face without actually being there. Now, in order for you to see the spot as appearing somewhere, it must certainly appear there. Yet it must appear there without appearing actually to be there, since you are not under the illusion that the spot actually occupies the space in question. The after-image must therefore be described as *appearing in* a location without *appearing to be in* that location. . . .

The only way to describe the after-image as appearing in front of the photographer without appearing to be in front of the photographer is to talk about the location that it occupies in your visual field. In your visual field, we say, the after-image overlays the image of the photographer's face, but nothing is thereby represented as actually being over the photographer's face. The after-image is thus like a coffee-stain on a picture, a feature that occupies a location on the picture without representing anything as occupying that location. (Boghossian and Velleman 1989, p. 93)

Roughly this argument has the form as follows:

- 1 We must describe a nonillusory after-image as appearing in a location without appearing to be in that location.
- 2 The only way to describe an image as appearing in a location without appearing to be in that location is to talk about the location it occupies in a visual field.

Hence when we talk about the location of nonillusory after-images we are talking about locations in a visual field.

The argument is valid, and I propose to concede the first premise to Boghossian and Velleman, even though one could raise difficulties with it. The more serious problems lie in understanding what the second premise and the conclusion mean.

I

Let us start with the conclusion. What have we endorsed when we endorse the existence of a "visual field"? Or, perhaps a better way to put this: when we commit ourselves to the existence of a visual field, what commitments have we *added* to those we already had?

This latter formulation is useful, since even before this particular dispute reaches any resolution, theorists will already have undertaken many ontological obligations. In particular, with the possible exception of subjective idealists,¹ theorists will already have endorsed the existence of *distal stimuli*--of physical objects and stimuli occupying physical space in front of the eyes. These are such things as photons which strike rods and cones, as surfaces which reflect light in the visible spectrum, as tables and chairs. They are objects and phenomena described by chemistry and physics, residing in their brute physical way out there in cold physical space.

Quite apart from the demands of common sense, theorists need these things because without them the entire story psychologists and neurophysiologists tell of vision, starting at the retina, could not be told. We could not mention rods or cones, retinas or optic nerves, photons or electron shells. All those items are physical items housed in the physical world.

Typically we take ourselves to be seeing some of such things. I look out the window and see a house and a tree. The house that I see is made of wood, a complex organic structure which came from other trees, and of brick, which contains considerable silicon. Such objects reside comfortably out there in the physical world, in that same space through which photons can pass. Not all things seen can be classified as physical *objects*; we also see the sky, the ground, lightning flashes, shadows, reflections, glares, and mists; but all such phenomena can be construed as physical phenomena in front of the eyes. For each of them physics can contribute something to the story of what one sees.

The ur-concept of a "visual field" is that of a *sum of things seen*; all three of the varieties I shall describe can fit under this heading. They differ over what it means to "see", and over what sorts of "things" can or cannot be seen, but they agree that in some sense or other subjects see things, and allow a "visual field" as a time slice--a mereological sum of

things seen at a given time.²

Now suppose we admit that we are surrounded by physical phenomena and that in some sense we see some of those phenomena. This gives the first variety of visual field. Define the *field of view* at time *t* as the mereological sum--the scattered totality--of physical phenomena seen at time *t*. The field of view is a large three dimensional physical phenomenon. It might be several miles deep. Its size and shape is determined at time *t* by the physical position of the head and eyes. With one's head in a closet, the field of view dwindles considerably. Turn off the lights, and it dwindles to nothing. But as long as one is seeing something, there exists a sum of things seen: a "field of view". It bears emphasis that the field of view is a physical phenomenon, not defined by one's psychological constitution. If the honeybee and I both see the same flower, there is something--that flower--which is literally in both our fields of view. This despite the fact that the honeybee and I do not see it in quite the same way! Furthermore, the flower itself turns out to be a latticework of organic molecules, or at a deeper level, a cloud of elementary particles, in mostly empty space. The "field of view" is so defined that its occupants might turn out to be clouds of elementary particles.

Even in this relatively simple version there is scope for confusion. Rival coordinate schemes might be used in different stages of vision: retinocentric, egocentric, allocentric. Is retinocentric space the same space as allocentric space? Although it is possible to construct psychological models under which these terms refer to distinct domains, it is not obligatory.³ Perhaps we have just the one set of places in the field of view; the differences in the different stages of processing lie in how those places are described, or in what mode of access or means the system employs to identify those places. Those differences can be quite significant, and it is obviously important to discover how we come to identify places in our surroundings. But the shift from retinocentric to allocentric coordinate schemes does not necessarily yield a new domain, a new set of locales; instead it may provide only a new way of organizing the same domain. The places are the same; what we gain is a new means of identification of them.

¹ Even Berkeley can be interpreted so as to endorse the existence of *distal stimuli*. He denies only that they are in front of the eyes.

² It is a sum, and not a set, for at least two reasons. First, sums, but not sets, can be located in space. A herd of buffalo might spend the morning in a pasture, then make a river crossing. A set cannot. Second, the same sum can be divided up in different ways. The sum of visible points might be the same as the sum of visible expanses, but the sets are quite distinct.

³ For example, visual perimetry is used to locate the scotoma or "blind spots" within a blindsight patient's vision, by degrees of azimuth and altitude from the fixation point. Nevertheless such measurement of the "visual field" is just measurement of the field of view, described in retinocentric terms.

II

Now for variety 2. It is plain that when Boghossian and Velleman talk about the "visual field" they are talking about something *distinct* from the field of view. The after-image, they say, does not appear to be located *between* you and the photographer, or *on* the photographer's face. It does not appear to be located anywhere among the physical phenomena in front of the eyes. But the after-image *does* appear in front of the photographer's face. Hence, they say, we must posit locations in a visual field, distinct from locations among the objects in front of the eyes.

So what is this second variety of visual field? In contemporary terms it is something closer to the sum of visual representings than to the sum of things seen. In classic terms, one sees by having visual impressions, and those impressions bear spatial relations to one another.⁴ The version 2 visual field is the sum of such impressions; I shall call it the *array of impressions*. The qualities of visual impression are dependent on the psychology of the host; the honeybee and I have distinct visual impressions, and perhaps there is no element that can be found in both (see Thompson, Palacios, & Varela, 1992). So even if we share the same field of view, we will not share the same array of impressions.

The classic idea is that visual impressions have properties that serve as natural signs or indicators of their distal causes. Sensations of red are arbitrarily associated with the physical properties that cause them; those same physical properties could just as well have caused sensations of green, or none at all. But visual impressions represent spatial characteristics of the distal scene in a different and less arbitrary way. The spatial relations obtaining within the array of visual impressions serve as a *map* of distal causes; they resemble or model the spatial relations among distal things. Crudely, if you have a visual impression of a red triangle next to a green square, then your impression of the red triangle is next to your impression of the green square. The array of impressions is the version 2 visual field; places in the visual field are places within it.

We can immediately make this idea more sophisticated by invoking the Sellarsian device of counterpart properties (see Sellars 1963, p. 193; Sellars 1968 pp. 25-30). We need not say that if you see a red triangle to the left of a green square, your impression of the red triangle is to the left of your impression of the green square. Instead the spatial characteristics ascribed to visual impressions are analogous to or modeled on the spatial characteristics ascribed to physical things. As Sellars puts it, there is some

counterpart relation, left*, such that your impression of the red triangle is to the left* of the impression of the green square. The key idea of these "counterpart" relations is that they have the same *structure* as the spatial relations obtaining among physical things. We have a family of counterpart predicates and relations, and they are isomorphic to the spatial properties and relations ascribed to things.

I take it that even this more sophisticated Sellarsian reading of "locations within the visual field" is still within the tradition. It still proposes an array of impressions--a version 2 visual field. Since the left* relation obtaining among the impressions is isomorphic to the "left" relation obtaining among their causes, the array of impressions can still serve as a map of those causes. Furthermore, since these counterpart relations are isomorphic to the spatial relations among things, it is fair to say that they resemble those relations. Sensations of red do not resemble their causes, but spatial characteristics of our visual impressions do resemble the spatial structure of their causes. So ideas of red are ideas of secondary qualities, while ideas of left or next-to are not. The Sellarsian amendment still preserves this central feature of the model.

For my purposes the defining characteristic of a version 2 visual field is that it is a sum of visual impressions, organized in such a way that spatial relations or counterparts to spatial relations obtaining among the impressions resemble or map the spatial relations among things. The "visual field" is not a "field" unless its elements bear something like spatial relations to one another. It must make sense to talk about locations *in* the visual field. Classically the visual field has a shape that does not change as one turns one's head; there is a place in it that is its center; and a red patch in it might be *next to* a green patch. Boghossian and Velleman endorse a modern descendant of this view.

In this they are by no means alone. The version 2 visual field remains a popular posit. For example, O'Shaughnessy (1980, pp. 167-210) gives a lengthy defense of the notion of the visual field, defined as

a two-dimensional psychological map wherein sensations stand to one another in merely two-dimensional relations like 'adjacent-to-left' 'less-adjacent-to-right' 'above' 'below' (O'Shaughnessy 1980, p. 176).

He agrees that after-images must be located in such a "psychological space": they occupy a two dimensional region within such a field. But after-images are also "projected" onto physical objects, where to be "projected" is to be a property of sensation that is "experienced as inhabiting something that lies without the mind of the experiencer." O'Shaughnessy says that an after-image is "projected onto whatever physical item occupies its sector of the visual field" (1980, p. 178). Baldwin (1992) points out that projectivist accounts do not all necessarily

⁴ This falls within the ur-concept of "visual field" if one invokes the classic view that what is directly seen is not a distal object, but a mind-dependent impression of that object.

endorse what is here called a version 2 visual field, but this one certainly does, since in its terms

our visual field is constituted by a two-dimensional array of visual sensations which the mind 'projects' onto physical space in accordance with causal connections between the structure of physical space and the intrinsic spatial structure of the visual field. (Baldwin 1992, p. 183).

In projection, psychological properties are literally misplaced: what in fact are properties of sensation are experienced as occupying places outside the mind (see Shoemaker 1990, pp. 133-4). If projection is defined as a relationship between two distinct spatial domains, one of those domains will turn out to be a version 2 visual field.

Here is one other diagnostic test that may help to determine whether a theorist has invoked the second variety of visual field. Most of those who talk of "visual space", and all who distinguish it from "physical space", have endorsed version 2. Consider the claim that visual space has a geometry that is distinct from the geometry obtaining among physical objects. Many exciting and confusing things have been said about this topic. Visual space is non-Euclidean! Perhaps it is spherical! Or hyperbolic! One interpretation that would make sense of these claims is that we have a domain of visual impressions, distinct from that of distal objects; that some family of relations obtains among those impressions, relations which are at least analogous to spatial relations among things; and that the geometry that describes those relations differs from the geometry describing physical things.⁵ A variant is to claim that the projection rules that map the relations among impressions onto the spatial relations among things cannot be written in Euclidean form; the "projective geometry" is non-Euclidean.⁶ Both versions endorse the

⁵ As one proponent says:

our immediate visual awareness consists of a phenomenal field of colors, visual space, whose geometrical and qualitative features are determined by causal connections with the physical objects being "seen" . . . it remains possible that both the topological and the metric structure of visual space is quite different from that of physical space. Thus, an attitudinal shift is required here away from direct realism, which numerically equates the two, to a more neutral attitude where a geometrical analysis can be made of our visual experience in and of itself. (French 1987, p. 115)

⁶ Some of the discussion of visual projective geometry can be interpreted as a convoluted way of talking about how painters represent a three dimensional scene on a two dimensional canvas. Perhaps in some sense for a painting to "look like" a three dimensional scene, the globs of paint cannot be laid on the canvas in accord with the rules of Euclidean projective geometry, but must

second variety of visual field. As intimated above, it is possible for a theorist to use the term "visual space" without implying that it is distinct from "physical space", but once one enters claims for a distinct "visual geometry", that possibility is foreclosed.

At any rate, theorists who deny the existence of a version 2 visual field are not thereby committing some *prima facie* absurdity. They are not denying the existence of all those things that you see in front of your nose. They are denying that we need a *second* set of entities and locations, in addition to those in the field of view. Perhaps our visual representations of space are not themselves organized spatially. It is possible.

III

But now the issue is joined. Boghossian and Velleman claim that we *do* need a second domain of entities and locations. "An adequate description of the after-image requires reference to two kinds of location--location as an intrinsic property of features in the visual field, and location as represented by the resulting visual experience. (Boghossian and Velleman 1989, p. 93) Why? The argument rests on the second premise: "The only way to describe the after-image as appearing in front of the photographer without appearing to be in front of the photographer is to talk about the location that it occupies in your visual field" (Boghossian and Velleman 1989, p. 93).

One way to show that their way is not the only way is to describe another way, which is at least equally plausible, and which mentions no locations other than those of physical phenomena. I believe this can be done. To account for after-images we need to mention retinal locations, but not locations in some distinct "visual field". In this way I hope to show that the facts adduced by Boghossian and Velleman do not *oblige* us to posit a version 2 visual field.

Here is a second way to tell the story. Your eyes are fixated at a certain point when the flashbulb goes off, flooding your face with photons. The lenses of your eyes focus some of this flood onto parts of your retina, where the rods and cones are momentarily "bleached" by the energetic onslaught. That is, those cells contain photopigments which isomerize when they absorb photons, and it takes time to replenish the stock. Typically your pupil has its diameter adjusted to the intensity of ambient illumination, so that only as much light is admitted as can comfortably be handled by the receptors below. But the flashbulb increases the photon

follow the rules of spherical or hyperbolic geometry. This strategy is pursued by Heelan (1983), who argues that the projective rules are hyperbolic.

flux by several orders of magnitude, and your pupil cannot react quickly enough. In some of the affected receptors, most of the available photopigment molecules might be isomerized as they absorb photons. (Even that's not enough to stem the flood; many photons will bounce off the membrane behind the retina and re-emerge out the eye, giving the classic "red eye" look beloved by amateur photographers.⁷) Those receptors are "bleached". It takes some time before additional photopigment can be synthesized.⁸

After the bulb goes off you shift your gaze to the photographer's face. The bleached receptors are temporarily useless; light falling upon them triggers no reaction, since there is no photopigment available to isomerize. They are, at least temporarily, out of commission. The portion of your field of view focused upon those receptors cannot be seen. That portion is a "visual solid angle": a conical region, with fixed angular coordinates given in retinocentric terms, extending out into space.⁹ The eye cannot register much, if any, information about things within that visual solid angle. That visual solid angle defines the outlines of the *after-image*. Within it you experience the characteristic phenomena: an initial blank spot, which changes hue and loses definition as the retina recovers from the overload.

Given its genesis, an after-image shifts whenever you shift your gaze.¹⁰ You cannot scrutinize it or scan it; you cannot look at it directly, since whenever you move your eyes to do so, it skitters away. So an after-image has a constant retinocentric location but inconstant distal ones. We feel little temptation to assign a distal location to the after-image, since it

moves with your eyes, and distal objects do not. One reason it is so quickly apparent that the after-image does not appear to be located on the photographer's face is that the face stays where it is when you move your eyes, but the after-image does not.

What sort of location *is* ascribed to after-images? Boghossian and Velleman say that it appears at a location without appearing to be at that location. Do we still need a second set of locales--those within an array of impressions--to house such things?

I think there are at least two alternatives. One is simply to identify the location of the after-image with its visual solid angle. This is a large conical volume in the field of view, extending outward from the eye indefinitely. Perhaps we could be a bit more definite and locate the after-image as at the place where this visual solid angle intercepts something else within the field of view. *If* you are seeing anything when you see an after-image, then that is where it is seen.¹¹

The simpler alternative is to deny that anything *is* seen when one has an after-image. There appears to be a spot in front of the photographer's face, but there is not. Perhaps the experience of having an after-image is an experience of something *other than* seeing. Within the visual solid angle defined by the bleached receptors, one cannot see anything (initially, at least). Perhaps within that angle after-imaging *rather than* seeing is going on.

At best the information you can pick up within that angle is information about the state of your retina, as the receptors recover from overload. Indeed, allow me to recommend a new attitude to take to your own after-images: treat them as indicators of the state of your own visual system. The effects of dazzling light have a complicated phenomenology and time-course, with progressive shifts in the apparent hues of the after-image and its surround. The colors that you seem to see may carry information about the regeneration rates of your three photopigments. For example, chlorolabe (the pigment in cones most sensitive to middle wavelengths in the spectrum) regenerates more quickly than erythrolabe (in long wavelength cones). A bright 500nm light will be absorbed preferentially by chlorolabe-containing cones. In principle such a light might bleach more chlorolabe than erythrolabe, and produce an after-image that initially looks red. As the red goes away, think "my chlorolabe is back in stock".

⁷ After a bright burst of light the retina becomes more transparent to light of the wavelengths the photopigments absorb, since after the pigment molecules absorb as many photons as they can, the remainder more readily pass through. By carefully measuring the wavelengths of the initial burst and of the light reflected back out of the eye, one can estimate the absorption spectra of the photopigments. This technique was one of the first used to estimate those spectra. See Kaufman 1974, p. 89.

⁸ The effects of dazzling lights are somewhat special; most after-images and aftereffects are not caused by bleaching of photopigments.

⁹ This is Gibson's term, but he in turn gives credit to Euclid's notion of "visual cones". See Gibson 1979, p. 69.

¹⁰ This discussion of the movements of after-images should not be taken to endorse the claim that after-images are entities that have location, or even that they exist. Instead "the after-image moves" is a handy abbreviation for "the visual solid angle focused upon the bleached receptors occludes different things in the field of view when one shifts one's eyes". The abbreviation is ubiquitous and useful, but it fails to imply that we can quantify over after-images or treat them as mental objects. In this sense you can "have an after-image" even though there is no entity identical with an after-image.

¹¹ The "apparent size" of the after-image depends on the distance of the first surface which intersects its visual solid angle. The after-image looks smaller on a nearby page than when projected onto a more distant wall. This relationship was first formalized in 1881 as Emmert's Law. See Boring 1942, p. 292.

If one adopts the view that after-imaging *rather than* seeing is going on, then after-imaging is not a visual representing of anything, but is a disruption or hitch in vision. You merely *seem* to see something. Now we do need to explain *why* you seem to see the spot where you seem to see it, but in principle it seems possible to explain that fact without mentioning any locations other than physical ones. The explanation would rely on the premise that if some receptors are "bleached", and light falling upon them has no effect, then at that time one cannot see anything within the visual solid angle of light falling upon those receptors. This premise makes no illicit references to locations in a visual field, and it seems relatively unproblematic. Filled out with descriptions of the array of retinal receptors and the optics of the eye, it would allow us to explain why you seem to see a spot *where* you seem to see it. That is, we could explain the location of the visual solid angle within which nothing is seen.

Talk about "the location of the after-image" simply takes for granted the critical claim that "the after-image" refers to something that has a location. Where is the after-image? I think at the end of the story we will say "Nowhere at all. There is no such thing." But before we can say that we need to tell the rest of the story.

IV

Along with after-images, Boghossian and Velleman cite other phenomena that, they claim, require locations distinct from those of physical objects in front of the eyes:

If you press the side of one eyeball, you can see this line of type twice without seeing the page as bearing two identical lines of type. Indeed, you cannot even force the resulting experience into representing the existence of two lines, even if you try. Similarly, you can see nearby objects double by focusing on distant objects behind them, and yet you cannot get yourself to see the number of nearby objects as doubling. And by unfocusing your eyes, you can see objects blurrily without being able to see them as being blurry. None of these experiences can be adequately described solely in terms of their intentional content. Their description requires reference to areas of colour in a visual field, areas that split in two or become blurry without anything's being represented to you as doing so. (Boghossian and Velleman 1989, p. 94)

Of these the experience of the double image is most vivid. A finger held between your eyes and a page you are reading will "look double". Two dark blurry outlines are seen, overlapping different portions of the page. But none of the words on the page become invisible. Each outline is dark

but translucent; you can read right through it.¹² Now there are not two dark blurry translucent objects in front of the eyes, or two of anything; there is just the one finger and the page. So the two dark translucent outlines that you seem to see cannot be identified with anything in front of the eyes, and it seems we must postulate a visual field to house them.

Boghossian and Velleman argue that the experience is *not* one of representing there to be two somethings in front of the eyes. The two dark outlines appear in front of the page without there appearing to be two dark outlines in front of the page. Since you are not representing there to be two somethings in front of your eyes, the doubling of the image cannot be explained solely in terms of intentional content.¹³ We must posit a visual field whose places are the places where those two images appear.

Again the task in the reply is to explain the appearance of the double image without postulating any locations other than distal ones. It is first worth noting a difficulty that remains even if we accept the existence of an array of impressions in which *two* areas *are* dark and translucent. Somehow even *that* will not capture how the finger looks when it looks double. Imagine a painting, in which two diaphanous outlines are superimposed on images of other objects. The problem is that there is no way to look at such a painting with two eyes and have an experience similar to that of the double image.¹⁴ Should a realistic painting of how things look have doubled outlines for everything more or less distant than the point of fixation? The most proximate such object is always the painter's nose, and on this line such paintings ought always to contain two diaphanous outlines of a nose, one on the extreme left, and the other on the extreme right. Somehow that is not what the scene looks like. What are

¹² In his notebooks Leonardo Da Vinci (d. 1519) noted the translucency of such objects to binocular vision, and concluded "If nature is seen with two eyes, it will be impossible to imitate it upon a picture so as to appear with the same relief, though the lines, the lights, shades and color be perfectly imitated" (see Boring 1942, pp. 283-4). After these notes were published in 1651 the translucency of objects to binocular vision became known as "Leonardo's Paradox".

¹³ The argument of Boghossian and Velleman is strikingly similar to C. D. Broad's (1927) discussion of the round penny which looks elliptical. Broad also argued that intentional content will not suffice: the penny can "look elliptical" even though we have no inclination to *judge* that the penny is elliptical. So the appearances oblige us to posit an elliptical *sensum*.

¹⁴ Visual linear perspective requires *both* a vanishing point and a *viewing* point. If the painting is not viewed from the viewing point, its perspective will be incorrect (see Gregory 1979). But, as Leonardo observed, if we employ binocular vision, then there will be *no* point from which the painting can be viewed so as accurately to depict the entire field of view, nose and all.

those blurry things on each side?¹⁵ Even if it were realistic, when you look at the painting, you would find the image of your nose competing with that of the painter's!

Perhaps we need to posit a three dimensional array of impressions. Aspects of the experience can only be captured in three dimensions, but then one begins to wonder why the spatial order of things in front of the eyes needs to be duplicated within the visual field. I suggest that such duplication is unnecessary; the appearance of the double image can be explained by reference to the three dimensional distal facts.

The prominent one is that one sees with *two* eyes, located in different places. The experience of the double image can be construed as *two* representings of one thing. We see one finger twice. This complicates my earlier account a bit: the two eyes have slightly different fields of view. They overlap considerably, but differ at the edges. More importantly, any object not fixated by both eyes occupies distinct visual angles in the two fields of view.

Now these facts go some ways towards explaining the characteristic phenomena of double images. Each eye can see whatever portion of the background the finger hides from the other eye, so each outline will seem translucent. The angles differ, so you will seem to see two outlines overlapping different portions of the background. The finger is out of focus, and so will be seen blurrily. We see the finger twice. Such a "double image" is characteristic of any unfused¹⁶ binocular vision. Suppose a creature has two eyes with finite "depth of field"¹⁷ and those fields of view overlap. Suppose the creature can focus both eyes on one object. Any object closer to the eyes than that fixation point will occlude distinct items in the two fields of view. Adding a "visual field" to this creature gains it nothing. Even without a "visual field," the creature would see the finger twice, blurrily, at slightly different visual angles.

So on this line the experience of "having a double image" is just a matter of seeing one thing twice. The doubleness reflects a real doubleness in the world: the fact that you have two eyes. You have two visual representations of it that are not fused; it presents two appearances.

¹⁵ In drawing his visual field, Ernst Mach wisely decided to depict the view from one eye only. Even so it is amusing to note that both the nose and the distant trees are in sharp focus. See Mach 1890, p. 16.

¹⁶ The presentations "fuse" when both eyes fixate on the object, so that it occupies the same visual solid angle in both fields of view, and it is in focus for both. Items at greater or lesser distances than the fixated one are not fused.

¹⁷ "Depth of field" is the range of depths in distal space within which objects remain in focus. With infinite depth of field (as with a pinhole camera), both sightings of the finger would be in focus. They would still not fuse, because of the disparity in visual angles.

It looks doubled, but it does not look as if there are two; and there are not two somethings of some kind that you see.

V

On the account I am suggesting, we need to admit the existence of a "field of view"--which is always just some sum of distal, physical phenomena--and of a perceiver, who sees things, or has "visual representations". The perceiver is another physical object, but one that has a special role, since the capacity to see is what defines the limits of the field of view. On this line we do need to acknowledge the existence of visual representations--or at least of states within an organism that constitute its seeing of things. Gibsonians urge caution in what one characterizes as a "representation", and they might deny that the states that occur within an organism when it sees have content and structure sufficient to be labeled "representations". Nevertheless such states must at least yield the division between those things that are and those that are not within the field of view of that organism at that time.¹⁸ More significantly, the accounts given above of both the after-image and the double image require states within the perceiver that (in some sense) represent items in that field of view.

But with that the admissions can stop. No further additions to our ontology are necessary. We do not need to add a version 2 visual field--a two dimensional array of impressions--and there is no good reason to believe in the existence of such an entity, at least in any known species. The eventual third variety of visual field will turn out to be necessary only if one thinks that visual states are robustly representational, since it describes the "intentional object" of visual representations--the world as represented visually.¹⁹ But even this third variety adds nothing to our

¹⁸ Gibson (1979, p. 111) defines the "field of view" of an animal at a time as that portion of the ambient optic array that "can be registered by its ocular system" at that time. This depends on position of the head and eyes, but also on the capacities of states of the ocular system to "register" events.

¹⁹ It may not be necessary to disagree with Gibson in order to invoke this third variety of visual field. His attacks on the notion of representation are typically aimed at the somewhat narrower notion of "re-presentation": that stimulation is somehow presented a second time. But in his work other more defensible versions of representation are employed. For example, a picture is described as a surface arranged to display "information about something else . . . We distinguish between the surface *of* the picture and the surfaces *in* the picture" (Gibson 1979, p. 282). He suggests that the objects depicted in the picture could be called "virtual objects" (p. 283). Virtual objects and surfaces are also mentioned in the accounts of shadow-casting experiments (pp. 172, 188) and in various phenomena of aperture vision (pp. 158, 259). Such "virtual"

ontology; it is just a different (and, as will be seen, dangerous) way of talking about states that have representational character.

This account could concede to Boghossian and Velleman the point that the doubleness of the double image cannot be explained *purely* in terms of intentional content. Perhaps the experience cannot be adequately described as a matter of representing there to be two blurry somethings in front of the eyes. There is a difference between having a double image of one finger and blurrily seeing something which looks like two fingers. But if we need more than intentional content to characterize this difference, I suggest that we appeal first to the fact that we have two eyes.

Suppose we admit the existence of visual representations—or at least of states of the observer that are its seeings of things. We could form a mereological sum of such seeings, and this would be another sum of physical states. But now it might seem that a version 2 visual field can re-enter the drama by the back door, so to speak. Recall that one characteristic of the array of impressions is that elements within it have locations distinct from those of distal causes. If visual representations turn out to be brain states, then those states have such locations. Even more alarmingly, much of the visual system employs "place coding", or is roughly somato-topical, so that adjacent areas in the field of view affect adjacent areas of the retina, adjacent areas of the lateral geniculate nucleus, and even adjacent areas of striate cortex. Much of visual (and sensory) physiology can be understood as a sequence of layered and somato-topical "feature maps". Different maps respond to different features in the field of view: spatial frequencies, edges, local motion, color, shape, and so on. The maps form tangled hierarchies, with primary visual cortex (area V1) at the bottom of most of them. Are these maps visual fields? Might some expanse of cortex, in which we find such a feature map, turn out to be the physiological instantiation of a version 2 visual field?

One immediate embarrassment is caused by the fact that visual physiology (and sensory physiology in general) employs a surprisingly large number of different feature maps. For example, the macaque monkey appears to have at least two dozen, and perhaps as many as thirty two, distinct areas of cortex, each organized somato-topically, devoted to distinct visual features (Felleman and Van Essen, 1991). If each of these is a "visual field", then the macaque has at least two dozen distinct visual fields. In which one of these should we locate *the* after-image? The

prospect of assigning it two dozen distinct locations palls. Nothing in the argument of Boghossian and Velleman provides the resources needed to carry out such a task.

Furthermore, cortical feature maps do not entirely preserve topology; they have tears and discontinuities, most prominently down the mid-line. Signals from the left hemi-field in both eyes travel to the right cortex. A light source traveling left to right in the field of view does not cause a continuous arc of excitation to travel across the cortex; when the light crosses the mid-line in the field of view, the neural locus of excitation will hop, in the reverse direction, across to the other cortex. One notes no phenomenological hitch or hiccup when this happens. Vision scientists sometimes say things like "all the visual fields start at V1", but they are speaking of feature maps, not arrays of phenomenal items. The split down the mid-line in all those feature maps is phenomenologically invisible. It remains logically possible that there exist creatures endowed with version 2 visual fields, whose representings of space themselves rely on spatial relations or counterparts to spatial relations. But it turns out, empirically, that we are not such creatures. We do not visually represent spatial relations in that way.

VI

The line I have developed so far still faces a compelling objection, which might be put as follows. When you hold a finger between your eyes and a page that you are reading, you *do seem* to see *two of something*. These "two somethings" that you seem to see cannot be identified with any object in front of the eyes. And each distinctly seems to be *somewhere*. Surely they do not seem to be at the *same* place, and there is a clear distinction between the places they seem to occupy and the places they do not.²⁰ These places where the somethings seem to be cannot be identified with places in front of the eyes, so we must admit the existence of a second set of locales, where such somethings can be found. It hardly takes an argument. Can't you just *see* that there are two of them? And if you can see two, how can you deny that they occupy different places?

Here I think we have reached the primal intuitions yowling in favor of a visual field. It seems that you can just see its occupants! The intuitive force of this premise should be granted. When you have the experience of a double image, you *do seem* to see two of something. The objection becomes even more seductive when couched in terms of *images*. Those

objects are, I suggest, intentional objects. Certainly if a picture can display information "about" something else, then we have enough of what philosophers consider "representation" to launch the third variety of visual field.

²⁰ Again this discussion of the location of the image should not be taken to endorse the view that images are entities that have location.

dark blurry outlines that you seem to see are unlike other objects that you do see, so let us call them *images*. By stipulation, when you have the experience of a double image, you *see two images*. These images do not occupy places in front of the eyes, and are just the sort of entity that would find a happy home in a visual field. Indeed, only in such an odd locale could such odd entities have their being.

This notion of "images" invokes the third and final variety of "visual field"--not the sum of things seen, or the sum of visual representings, but the sum of things *as* represented visually--the "intentional content" of your visual representations. To describe this third variety of visual field is to describe the world as it is represented visually: what the world would be if it were just as it visually appears to be.²¹ This is a treacherous and complicated notion, but it does get used. By stipulation, seeing a dark blurry translucent *image* is just a matter of *seeming* to see something which is dark, blurry, and translucent. The dark blurry translucent image is the "intentional" object of one's visual representation; the third variety of visual field is filled with such entities.

Now if we have visual representations at all, then in some sense we have a version 3 visual field. To describe the content of those visual representations, describe the world as it appears visually. We could then talk about the objects within that world and the relations they bear to one another. This would be a devious but understandable way of talking about visual appearances. The objects described would be "virtual": they are objects *as* represented. Some of them would not exist.

Boghossian and Velleman decry the limits, not only of the first variety of visual field, but also of this third variety. They claim that it too is inadequate to describe the experience of an after-image or a double image. After they describe the after-image as appearing in a location without appearing to be in that location, they go on to say

this description is not within the capacity of any intentionalist theory. An intentionalist theory will analyse the visual appearance of location as the attribution of location to something, in the intentional content of your visual experience. But the intentional content of your visual experience is that there is nothing at all between you and the photographer. (Boghossian and Velleman 1989, p. 93)

An intentionalist theory is one that confines itself to a version 3 visual

²¹ Insofar as our visual representations are veridical, a description of the world as represented visually is just a description of the world. If visual representations never erred, this third variety of visual field would be just the same as the first. But if visual representations are non-veridical, the third variety of visual field describes how a possible world *other than* our own *would* look. (See Kraut 1982; Lycan 1987, p. 88.)

field. Boghossian and Velleman insist that neither version 1 nor version 3 will do; we also need a version 2. I hope to have shown that the argument for this necessity fails, and that the first variety alone can suffice; but if we posit a version 1 visual field, are we committed to the existence of something of the third variety as well?

When we start talking about images as "virtual" objects, or objects *as* represented, we are invoking this third variety of visual field. One relatively clear instance can be found in discussions of mirror images. When you look in a mirror, what do you see, and where is it located? C. D. Broad suggested that what you see is made up of *sensa*--mind-dependent visible entities similar to those seen elsewhere. The direction of the *sensum* is identified by moving your head until the *sensum* is in the center of your visual field, and then following your nose. The direction in which you would walk is the direction of the *sensum*. Its distance is the number of steps you would need to take to reach that source "if, in fact, the medium were homogeneous" and the *sensa* "were due to the transmission of light directly from this source" to your eye (Broad 1927, pp. 324-5). This specifies a location *behind* the mirror. Broad says that that location is the location of the mirror-image; it is "partially optically occupied" by the *sensa* which make up that image.²² This view has some recent instantiations:

Mirror images provide a good analogy... We see them, yet they are nothing in the physical world. The mirror image of my face appears behind the mirror, yet there is nothing there but bricks. The mirror image is there because I see it there, and not the other way around, namely, that I see it there because it is there. No wonder then that no one else can see the *same* mirror image. (Vendler 1994, p. 322)

Vendler here endorses the claim that one sees something that is located behind the mirror. He defends the view that mirror images are nothing in the physical world, and that their existence consists in being perceived (see Vendler 1991).

Now it really is very odd to locate the mirror image behind the mirror, back there inside the bricks. The physical location identified by Broad's directions has no causal role at all in your current visual experiences, and it is similarly odd to place any mind-dependent entity back there. But there is a sense in which objects reflected in a mirror look as if they are arrayed behind it.²³ For example, the rear-view mirror in an American

²² It is "partially optically occupied" in that those *sensa* are not visible from all angles around the location, but only from positions in front of the mirror (see Broad 1927, p. 329).

²³ "An object seen by Reflexion or Refraction, appears in that place from whence the Rays after their last Reflexion or Refraction diverge in falling on the

automobile is forward and to the right of the driver. If you are driving, and, using such a mirror, you see a car that is traveling twenty feet behind you, there is a sense in which that car appears forty five degrees to your right and twenty feet in front of you. That is where your eyeballs are focused. An American automobile seen in the rear-view mirror looks British-made: the steering wheel and the driver appear on the right-hand side of the car. I suggest that such locations can best be understood as "virtual locations": as locations within our third variety of visual field.²⁴ Visually you represent the world as if there were a British automobile hanging in space twenty feet in front of you, forty five degrees to the right. That is the place where an automobile would be, if the world were as represented. In fact there is nothing visible to you at that location, and there may be no British vehicles in the vicinity, but you represent the world as if there were. We have a "virtual object" or "image", located behind the mirror.

This terminology is unobjectionable until, in the next breath, we forget how it was introduced and being talking of the places where those somethings that we seem to see *are* located. That some qualities appear at a place does not imply that there is a place at which those qualities appear. The context "seeming to see *x*" is paradigmatically intensional; you seem to see a British car in front of you, but there is no British car that you see. Talk of images makes it too easy to forget the confines of intensional contexts. For example, we might allow, as above, that the experience can be described as *seeing an image*. You see an image of a British car,²⁵ twenty feet in front of you, forty five degrees off to your right. But there is no British car on the road, much less in that location, so the thing you seem to see at that location *does not exist*.

Clearly this terminology has its dangers. It is dangerous to speak of virtual objects as if they are real, and unfortunately that is the only way

one can talk about virtual objects. The logic and grammar of object-talk is so powerful that we forget that these objects are merely intentional ones. One describes the world as represented visually; that "virtual" world is the third variety of visual field. But "adding" such a visual field does not add anything to one's ontological commitments. We can talk of the objects in that world--of their properties and relations--provided we remember that perhaps none of them exist. If by stipulation whenever you seem to see something, you are seeing an *image*, then the image would be a denizen of that world. Its location may be *mere* appearance.

Thankfully, such images, like unicorns, fictional characters, and other things that do not exist, occupy no space at all, and so there is no special problem in making room for them in our ontology. We no more need places for them than we need places for our fictional characters. Indeed, on this interpretation the visual field is the perfect place to house Tweedledum, Tweedledee, and all the other entities found through the looking-glass.

VII

At the end we have three distinct interpretations for talk about the occupants of a "visual field": a field of view, an array of impressions, and a virtual world. Only under the first of these interpretations do we, in any ordinary sense, see those occupants. Indeed most reports of the "visual field" are best construed as descriptions of the field of view, coordinatized in retinocentric terms. One takes the attitude of a painter or photographer towards that distal sum, and describes the visual solid angles occupied by the things one sees. This attitude is useful in photography or painting; it helps one to predict what will fill the photo or the canvas. The small pasture in which one is standing typically occupies a much larger visual angle than that distant majestic peak, and noticing this can help one avoid a disappointing photograph. It also helps one notice aspects of the field of view that one never previously noticed. One might notice that a painting of the barn in that pasture would have to use slightly different hues for the two walls, if one of them is in shadow; that the shadows themselves have hues; that the paints one would use change depending on the time of day, and so on. One learns to describe the scene in terms of how a picture of that scene would look: a monocular and momentary field of view, described in retinocentric terms. Because the eventual picture is two dimensional, the description proceeds in two dimensional terms as well.

Spectator's Eye." (Newton, *Opticks*, Book I Part I axiom VIII). Newton goes on to say: "For these Rays do make the same picture in the bottom of the Eye as if they had come from the Object really placed at *a* [behind the looking glass] without the Interposition of the Looking-glass."

²⁴ Many of the characteristics that Vendler ascribes to mirror images can be explained by the hypothesis that he is describing a species of intentional object. Such objects exist only in an "analogous" sense, are not necessarily occupants of the physical world, and do not share a genus with physical substance. Their *esse* is strictly *esse pro*; their existence is exhausted in being perceived (represented). But one difficulty is that one cannot claim to see oneself in a mirror, since in the mirror right-handers look left-handed, and conversely. Amusingly, in *Through the Looking-Glass*, Tweedledum was a mirror image of Tweedledee (see Gardner 1965, p. 231).

²⁵ Or perhaps it is a British-car-image *of* an American car. See Goodman's (1976) distinction between black-horse-pictures and pictures *of* black horses.

Such vision is aptly described as “snapshot vision”.²⁶

These practices can help explain why positing a version 2 visual field remains so popular and natural. The artist’s retinocentric attitude yields descriptions of the things seen, cast in terms of how a *picture* of them would look. It is all too easy to confuse these with descriptions of a picture-like thing. But with that tiny step, the version 2 visual field is launched. We find ourselves looking at our own sensations, like visitors locked in a picture gallery.

As argued above, a minimal ontology is one that stops with the entities needed for a version 1 visual field. Ordinarily we take ourselves to be seeing physical things, or at least phenomena physically in front of the eyes, about which physics might have something useful to say. The other two varieties of visual field assign a very different status to their occupants. In version 2 those occupants are distinct from physical phenomena physically in front of the eyes, and in version 3 they might not exist at all. Now there is nothing wrong with arguing that visual perception can best be explained, or perhaps can only be explained, by such radical revisions in our ontology and core convictions. Such arguments, like Boghossian and Velleman’s, are worth making, and worth answering. But the attitude that must be challenged is one that takes the version 2 visual field as a premise, as an observational datum. So for example O’Shaughnessy (1980) says

...the psychological datum is, not merely a set of simultaneous visual sensations, but in addition their standing to one another in relations like next-to, farther-off-than, etc. (O’Shaughnessy 1980 p. 171)

I urge that this is no “datum”, or at least that it is a “datum” only for those who have already radically revised their beliefs about what objects they

²⁶ Of course Gibson (1979, pp. 303-4) argues that because of the severe constraints imposed on “snapshot vision”, it allows little information pick-up, and so does not reveal much of anything about normal (ambient) processes of visual perception. Normal vision cannot, he says, be understood as a series of snapshots. Furthermore there is no good reason to believe that adults who adopt the artist’s retinocentric attitude thereby become conscious of their own visual sensations; even with all the elaborate stage-setting, such adults still remain conscious of nothing but “the surfaces of the world that are viewed now from here”—conscious, that is, of portions of the field of view (Gibson 1979, p. 286). Gibson clearly and correctly denies that adopting the artist’s attitude demonstrates the existence of a two dimensional patchwork of visual sensations, and so he repudiates many of his earlier (1950) claims on behalf of the “visual field”. That (1950) terminology named a variety of what I call a version 2 visual field; the “visual world” was version 1, now called the “field of view”. By 1979 the 1950 “visual field” is not seen, not needed, and not missed.

see. Typically, if one looks around a room, one sees how the furniture in that room is arranged. Staring at the furniture, no matter how intently, is not going to tell you how your sensations of the furniture are arranged. It just tells you how the furniture is arranged. Sophisticated argument is needed to establish the conclusion that what you see is really an arrangement of visual sensations, bearing spatial relations to one another. Those who oppose this conclusion will also oppose the presumption that its truth could be established by merely looking around the room.

Like many phenomenological disputes, arguments about the contents of the “visual field” often grow heated and inexplicably contentious. Why do otherwise reasonable people disagree so passionately about what they observe in their respective visual fields? (How could they?) Perhaps one reason is that those putative observations mask substantively different theories. Pointing this out will admittedly not end the disputes, but it may help end some of the cross-talk.

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