

Afterimages and Sensation

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1. Introduction

According to *purists*, visual experience can be exhaustively characterised in terms of a subject's apparent perspective on external, public reality. Visual experience presents us (or if we are subject to illusion, apparently presents us) with aspects of the world beyond us—nothing more, nothing less. According to *sensationalists*, we cannot adequately characterise experience solely in terms of a subject's apparent perspective on external, public reality. In addition, or instead, we must appeal to visual sensation, in some sense of that vexed term.^{1, 2}

Afterimages have long formed a core part of the sensationalist's critique of purism. Afterimages, so the argument goes, are manifestly different in character to ordinary perceptual experiences of the publicly visible world. As a result, they cannot be accounted for solely in terms of the ways in which apparent aspects of that world are presented to us. Instead, they must be characterised in terms of visual sensation. Critics of visual sensation have failed to provide an adequate response to the objection from afterimages. Even Ryle, who famously declares visual sensation to be a myth—the product of misguided philosophical-cum-psychological theories which 'trade on, and pervert' our ordinary understanding of sensation as bodily feeling (1949: 243)—confesses to a

¹ Purists include pure representationalists such as Harman 1990; Tye 1992, 1995; Dretske 1995; and Byrne 2001; but also relationalists such as Campbell 2002; and Brewer 2011. I discuss the varieties of sensationalism below in §3. For related characterisations of the debate and discussion see, for example, Martin 2002: 377 and Block 2003: 165.

² Note that, although it is both common and natural to contrast purism and sensationalism, sensationalism is not strictly speaking the denial of purism. A theorist might eschew the notion of visual sensation in purist spirit, yet allow for qualitative differences between experiences in which the same objects are presented, and so reject purism as defined in the text. For instance, a representationalist might hold that experiential content was Fregean, not Russellian.

‘residual embarrassment’ concerning afterimages. For, as he admits in the final paragraph of his paper ‘Sensation’, he is ‘stumped’ to provide an adequate account of their nature without ‘falling back on to some account very much like a part of the orthodox theories of sense impressions’ (1965: 203).

This paper has two central aims. First, to rescue Ryle from embarrassment by providing a positive account of afterimages which is both phenomenologically adequate and empirically attractive. Second, to demonstrate that the objection from afterimagery is a wholesale failure. In charting this course I elicit two general morals. The first moral is that philosophers of perception need to expand their diet of examples. One major reason that afterimages have so impressed philosophers—both sensationalists and purists alike—is that they have failed to recognize the diversity of our ordinary perceptual experience, and so failed to recognize the availability of the positive account here offered. The second moral is that even where our concerns are restricted to appearances, we ignore empirical work at our peril. Confined to their armchairs, philosophers have mischaracterised the ways in which afterimages in fact appear. Empirical studies of afterimagery supply the necessary corrective.

The paper is divided into thirteen short sections. In section three, I introduce the basic claim behind sensationalist appeals to afterimages, namely that afterimages appear in ways which are incompatible with their being apparent presentations of public objects. I consider six alleged appearances.

- i. Afterimages do not appear to be material objects.
- ii. Afterimages remain apparent even when one closes one’s eyes.
- iii. Afterimages do not appear to exhibit size constancy.
- iv. Afterimages do not appear to exhibit kinetic independence/directional constancy.
- v. Afterimages do not appear to be occludable.
- vi. Afterimages do not appear to afford multiple perspectives.

Sections four through six respectively discuss appearances (i)–(iii). I accept that afterimages possess these appearances. However, I offer an account of afterimages—the light illusion account—which accommodates these appearances without any appeal to visual sensation. In

section seven, I argue that the light illusion account is to be preferred to sensationist accounts on empirical grounds. The light illusion account naturally meshes with independently motivated principles governing the operation of the visual system; in contrast, sensationist accounts demand novel and spandrel-like modes of operation. This defence of the light illusion account fulfils the first aim of the paper.

Section eight introduces the remaining three alleged appearances (iv)–(vi). In sections nine through eleven, I argue in turn that after-images lack each of these alleged appearances. I demonstrate this by appeal to various psychophysical experiments. I conclude that none of the ways in which afterimages in fact appear are incompatible with their being apparent presentations of publicly visible objects. The sensationist appeal to afterimages thus fails. This fulfils the second aim of the paper. I end by considering a series of objections in section twelve before concluding in section thirteen. I begin, however, by saying a little more about our target phenomenon, highlighting some of its complexities from a scientific perspective, complexities which are liable to falsify what we might assume from the armchair.

2. Afterimages

Richard Gregory, one of the most eminent vision scientists of the late twentieth century, offers the following brief characterization of after-images.

AFTER-IMAGE. An image seen immediately after the intense stimulation of the eye by light has ceased. For about a second, the after-image is 'positive', and then it turns to 'negative', often with fleeting colours. The positive phase is due to after-discharge of the receptors of the eye; the negative phase is caused by loss of sensitivity of the receptors as a result of bleaching of the photo-pigments by the intense light. (1987: 13)

A negative afterimage is an image whose brightness relations are approximately reversed with respect to those of the stimulus; a positive image is one whose brightness relations are approximately the same.³

As Gregory's own work testifies, this characterization oversimplifies in at least four ways. First, the characterization mentions only one of the ways in which we can ordinarily enjoy afterimages: the kind of

³ Vision scientists also talk of 'complementary afterimages'. These are images whose colours are approximately complementary to the colours of the stimulus. As Loomis (1972: 1587) notes, such images occur under similar conditions to negative images, and so can be considered theoretically together. Thus, commonly 'negative afterimage' refers to an image which is both negative in the strict sense, and also complementary.



Figure 1. Stare steadily at the central cross for thirty-seconds, then look at a blank sheet of paper or close your eyes. Image believed to be in the public domain.

situation which commonly occurs in the immediate aftermath of seeing a bright light such as the sun, or a camera flash. However, you can also enjoy afterimages after staring for some time at an ordinarily illuminated object. For example, if you fix your gaze steadily on the central cross in Figure 1 for thirty seconds, and then close your eyes and stare as if into the mid-distance (or stare with open eyes at a white piece of paper), you are likely to enjoy a negative afterimage, somewhat resembling a youthful Bob Dylan.

Second, light stimulation is *not* necessary to experience an afterimage. In subjects with strong visual imaginations, afterimages can be evoked by merely imagining stimuli (James 1890; Weiskrantz, 1950; Oswald 1957). This refutes a philosophical truism, namely that '[a] blind man cannot have after-images' since 'it is necessary to have seen some object to have an after-image of it' (Furberg and Nordenstam, in O'Connor et al. 1959: 99).⁴ Relatedly, it seems likely that afterimages can be experienced following vivid dreams (Gruithuisen 1812; Alexander 1904; Oswald 1957). Again, this confounds a philosophical truism,

⁴ This truism is refuted by a number of cases: (1) conditioned afterimages evoked solely by the conditioned (e.g., auditory) stimulus (Davies 1974a, 1974b); (2) afterimages following hallucinations (Erickson and Erickson 1938); (3) afterimages experienced following the presentation of light to a temporally pressure blinded eye on release of pressure (Exner 1879; Craik 1940; Cibus and Nothdurft 1948); (4) afterimages experienced in the absence of prior conscious experience in subjects with blind-sight (Weiskrantz 2002; *contra* Masrour forthcoming).

namely that ‘if a person who has been asleep for twelve hours claims that the very first thing he saw on opening his eyes was an afterimage, then we know that his claim is false’ (Jones 1972: 153).

Third, as Kolehmainen and Tuomisaar put it, the ‘locus of the processes that give rise to after-images has been the subject of an entertaining controversy for more than a century’ (1969: 45). There is now substantial evidence that afterimages cannot be accounted for solely as a photochemical process (as proposed, e.g., in Craik 1940 and Brindley 1962). Rather, at least under certain experimental conditions, neural adaptation in the retina forms an essential part of the process (e.g., Loomis 1972; Virsu and Laurinen 1977). Furthermore, a number of recent findings evidence significant cortical involvement in the formation of afterimages (e.g., Shimojo et al. 2001; Suzuki and Grabowecky 2003; Gilroy and Blake 2005). These findings bear on the issues below since, as I argue, many sensationalists implicitly cleave to an out-dated, purely photochemical conception of afterimagery.

Fourth and finally, Gregory defines an afterimage as an *image* seen after light stimulation has ceased. This idea, implicit in the term ‘after-image’ itself, is problematic for at least two reasons. Firstly, it suggests that afterimage experiences are a kind of imaginative as opposed to a kind of perceptual experience. Secondly, it suggests that afterimage experiences involve awareness of some kind of entity, an image. We should reject both claims (*contra* Smart 1995: 550). Afterimages are a kind of perceptual experience, and in enjoying them we are not literally aware of any images.⁵

These brief remarks highlight some of the complexities of afterimagery from a scientific perspective. They also highlight how these complexities are liable to falsify hasty armchair pronouncements. So cautioned, and with our target phenomenon better in view, I now turn to appeals to afterimagery made by philosophers.

3. Afterimages and Sensation

The contention that afterimages reveal the existence of visual sensation, and so the untenability of purism, is a theme with many variations, for there are many different ways of understanding the notion of visual

⁵ The traditional solution to these traditional complaints is to speak of *after-sensations* (James 1890: Ch.18, 44; Stout 1932: 134, 282). However, this term is no less problematic given that my central aim is to reject the classification of afterimages as, or as involving, visual sensations (at least in modern senses of that term). A better remedy is to speak in terms of *after-percepts* (Browning 1892). But for reasons of familiarity I retain the standard terminology despite its unwelcome connotations. I speak loosely of ‘afterimages’ both in relation to afterimage experiences and to their objects, even though these are wholly apparent.

sensation. Notoriously, afterimages are a central weapon in the sense-datum theorist's armoury. G. E. Moore appeals to them as incontestable examples of sense-data, defining what it means to 'directly see' an object in terms of the seeing that is said to obtain when we 'see' an afterimage.⁶ Jackson (1977: 51f.) likewise offers afterimages as paradigmatic examples of sense-data. And O'Shaughnessy calls them into service in defence of his sophisticated sense-datum theory, taking them to be the 'most unproblematic' (2000: 502) and 'unexceptional defining example' (ibid.: 468) of a visual sensation, where a visual sensation is thought of as 'the immediate material object of ... visual experience' (ibid.: 467).⁷

More recently, afterimages are regularly cited as a counter-example to pure representationalist views of perceptual experience, according to which the phenomenal character of perceptual experience can be exhaustively characterised in terms of its representational content, and correlatively as evidence of sensational (i.e., intrinsic, non-representational) properties of visual experience.⁸ For example, Boghossian and Velleman (1989) argue that no representational content can adequately capture the nature of afterimagery and that, as a result, we must recognize the existence of a sensory field modified by intrinsic sensational qualities.⁹ Similarly, Block (1996) appeals to afterimages as evidence of what he calls 'mental paint' or 'mental latex';¹⁰ and Kind (2008) offers afterimages as a counter-example to the transparency of experience, and evidence of visual qualia.¹¹

A third variant on the theme of afterimages and visual sensation is explored in recent work of Smith (2002) and Siegel (2006; 2010: Ch.7).¹² Smith and Siegel are not concerned to reject a representationalist

⁶ See respectively Moore 1942: 644, 1962: 20, 183, and Moore 1942: 629–632, 1962: 119, 136. Moore 1939 contains his most famous discussion of afterimagery. See Malcolm 1953 for critical discussion.

⁷ O'Shaughnessy continues: 'the sheer existence of perceptual and especially visual sensations seems to me the nub of the arguments supporting the existence of sense-data' (ibid.: 505). See also Casullo 1987.

⁸ If defenders of this counter-example were correct, afterimages would equally be a counter-example to pure relationalist views (e.g., Campbell 2002, Brewer 2011) according to which the phenomenal character of experience can exhaustively be characterised in terms of our relations to external objects and their properties.

⁹ A picture articulated in Peacocke 1983. For Peacocke's current view of visual sensation see his 2008 where afterimages are mentioned as a key example.

¹⁰ According to Block, experience has non-representational properties in two senses: mental properties that represent things but whose phenomenal character is not itself given by any representational content (mental paint), and mental properties that do not represent anything (mental latex).

¹¹ See also: Wright 1983; Baldwin 1992; Brown 2009, 2010.

¹² See also: Langsam 2006; cf. Burge 2009; Block 2010.

account of visual experience. Rather they suggest that to count as genuinely perceptual, experiences must possess a certain *kind* of content or phenomenal character. ‘Inner light show’ experiences—including at least certain afterimages—are said to lack this content. As Siegel puts it, ‘There are in effect two kinds of objects of visual experience. The first, associated with visual perceptual experiences.... The second, associated with visual sensations’ (2010: 177).

Though very different, these three kinds of account rely on a common core idea, namely that afterimages manifestly appear in ways that are incompatible with their being apparent presentations of publicly visible objects. As Block puts it in his defence of mental paint: ‘Afterimages—at least the ones that I have tried—don’t look as if they are really objects or as if they are really red. They look ... illusory.’ (1996: 32)¹³ What exactly is it about the appearances of afterimages that leads Block and others to say this? At least the following six features have been put forward as grounding the alleged manifest non-publicity of afterimages.¹⁴

- i. Afterimages do not appear to be material objects.
- ii. Afterimages remain apparent even when one closes one’s eyes.
- iii. Afterimages do not appear to exhibit size constancy.
- iv. Afterimages do not appear to exhibit kinetic independence/directional constancy.
- v. Afterimages do not appear to be occludable.
- vi. Afterimages do not appear to afford multiple perspectives.

In what follows I discuss each of these ways in which afterimages are alleged to appear. With respect to (i)–(iii), I accept that afterimages possess the relevant appearances. However, I offer an account of afterimages—the light illusion account—which accommodates these appearances without any appeal to visual sensation. With respect to (iv)–(vi),

¹³ In what follows, I ignore Block’s claim about looking red which seems to me plainly false; see, for example, Westphal 2010; also Moore 1962: 20; Boghossian and Velleman 1989: 86.

¹⁴ Occasionally philosophers claim that afterimages are just *obviously* not presented as aspects of external, public reality, without appeal to any particular aspect of their appearance. I address this suggestion in §12.1 below.

I argue that afterimages do not possess the relevant appearances. I demonstrate this by appeal to various psychophysical experiments. In sum, I argue that none of the ways in which afterimages in fact appear are incompatible with their being apparent presentations of publicly visible objects. Afterimages in no way force us to abandon purism, nor to recognize the existence of visual sensation.

4. First Appearance: Non-materiality

Boghossian and Velleman cite afterimages as grounds for rejecting representationalist accounts of perceptual experience together with dispositional theories of colour. In both cases, their arguments explicitly ‘rest on the possibility ... of seeing an after-image without illusion’ (1989: 93).¹⁵

This problem would not arise if after-images were full-blown illusions. That is, if seeing an after-image consisted in seeming to see a material object suspended in physical-space.... But after-images are not seen as material objects, any more than, say, a ringing in one’s ears is heard as a real noise. (1989: 86–7)

Here Boghossian and Velleman concur with Block’s intuition that afterimage experiences are manifestly discriminable (by reflection on experience alone) from perceptual presentations of public objects. That is why they are not illusions. But Boghossian and Velleman flesh this claim out in a particular further way. It is because afterimages are not seen as *material* objects suspended in physical space that they cannot be counted as illusions.¹⁶

A number of representationalists have attempted to offer accounts of afterimagery on which they *are* treated as illusory presentations of material objects. Smart notoriously suggests that having a yellowish-orange afterimage is an illusion of seeing ‘an orange illuminated in good light in front of [one]’ (1959: 149). More imaginatively, Tye suggests that experiencing a red afterimage on a yellow wall is ‘similar perhaps to ... viewing (in dim lighting) a bloodstain on a transparent sheet of glass suspended between oneself and a yellow background

¹⁵ Cf. Austin (1962: 27) who claims that afterimages ‘certainly aren’t’ illusions (nor delusions).’ He declines to offer any positive account, however.

¹⁶ I am equally sceptical that (subjective) tinnitus should force us to acknowledge the existence of auditory sensation but the defence of that claim is beyond the scope of this paper.

surface' (2000: 85).¹⁷ These accounts are inadequate in various ways. Westphal, for example, notes a number of more or less plausible contrasts between the ways afterimages typically appear and the ways material objects typically appear, any of which would serve to discriminate between a floating orange, a bloodstain or a patch of paint (which is the example he considers) on the one hand, and an afterimage on the other.¹⁸

Here are some of the differences: (1) The colour of the patch is in the surface mode. (2) The afterimage colour lacks texture and grain. (3) Afterimages are relatively unstable and change in colour. (4) Afterimages lack sharp outlines. (5) Afterimages move with the eye. (6) Afterimages are in some sense self-illuminating, and they can be seen in the dark. But the patch is not self-illuminating. (1991: 109)

However, with a little more imagination, the representationalist can meet Westphal's criticisms. Clouds are material objects which lack sharp outlines or a surface. They can also be relatively unstable, especially in high-winds. Certain moulds are material objects which self-illuminate: they 'glow in the dark'. Thus, we can imagine a further epicycle in this dialectic in which the representationalist suggests that afterimages are illusory presentations of glowing clouds rapidly shifting their position and colour.

Nonetheless, Boghossian and Velleman are right that we should reject all such approaches. For afterimages simply do not appear to be material objects of any kind. The visible world is, arguably, sorted into objects which are perceived as having a nature which goes beyond the purely visual, and those which are not so perceived. As Martin develops the thought: 'one aspect of the visible world that is manifest to us, and an aspect of some objects that is also manifest, is whether they are pure visibilia or not' (2010: 207). Pure visibilia include objects such as rainbows and shadows which are not perceived as having properties beyond those detectable by vision. Material objects are not purely visible: they are typically perceived as having natures which extend along

¹⁷ Other accounts of afterimages as illusions hide behind the vagueness of the ubiquitous term 'patch', proposing, for example, that '[w]hen one has an experience of a red circular afterimage, the content of the experience is—to a first approximation—that there is a red circular patch at a certain location' (Byrne and Hilbert 2003: 5; cf. Smart 1959). This provokes the natural retort (cf. Austin 1962: 49) that afterimage-experiences are quite unlike experiences of seeing patches of paint, grass or cloth (all, I take it, paradigms of patches).

¹⁸ I discuss the relationship between afterimages and eye-movements in §9, below.

dimensions beyond those that we can detect visually, for example, as excluding objects from the physical space that they occupy. This fact about material objects—that their natures go beyond the purely visual—is something that we *can* typically detect visually. In this minimal sense, we can see material objects as such: as objects which are not purely visible objects.¹⁹

The apparent sorting of the visual world into the purely visible and the material (i.e., not purely visible) that Martin draws our attention to allows us to explain why Boghossian and Velleman are right to reject the material illusion accounts of Smart, Tye and others. Afterimages are apparently presented to us as pure visibilia. As a result they are marked in appearance as differing from material objects, be they oranges, bloodstains or glowing clouds. However, as is now obvious, that afterimages are not seen as *material* objects in no way commits us to the view that they are not illusions. For there are many things in the public, visible world which we see which are not material objects (nor typically seen as such): rainbows, shadows, highlights, fiftows (bodies of filtered coloured light, see Sorensen 2008), holograms, beams of light, glories, mirror images, and the vault of the sky, for instance (cf. Martin 2010: 187–9). It is thus a patent non-sequitur to move from ‘*x* is not presented as a material object’ to ‘*x* is not presented as a publicly visible object’.²⁰

¹⁹ I want here to remain neutral both as to whether pure visibilia actually lack a nature which goes beyond the purely visible (i.e., have no properties not detectable by vision), and if so, as to whether this is made manifest in visual experience. I take it that Martin’s view is that pure visibilia can, at least on occasion, be perceived to be exhausted by their visual natures. For present purposes it suffices that visual experience does not present pure visibilia as possessing a non-visual nature (except, of course, in cases of illusion).

²⁰ The same fallacy generates the adverbialist account of afterimages in Bigelow, Collins and Pargetter (1990). They endorse the *non sequitur* as follows: ‘After-images need not be illusions. When you see an after-image you do not always seem to see a material object.’ (1990: 280) And later: ‘visual experience does not represent the after-image as a material object at all.... There does not appear to be any object, which is seen as having the property of being yellow’ (ibid.: 281). The failure to recognize the existence of non-material public objects of vision plausibly motivates the radical position adopted by Schroer (2004) in his otherwise helpful essay in defence of representationalism, on which afterimages are alleged not to appear as ‘composite objects’. Psychologists also conflate the non-material with the unreal. Thus, Gregory declares, ‘The central question for theories of vision to answer is how objects—solid things existing in space and time—are seen from the very different ghostly images in eyes.’ (2008: 408) Gregory may be right about the central question. But he is wrong about the contrast class to solid objects.

These reflections naturally prompt the following suggestion: after-images are illusory presentations of pure visibilia such as the light phenomena just listed.²¹ Call this the light illusion account. If the light illusion account is right, Boghossian and Velleman's argument collapses. Afterimages can simply be thought of as illusions, just not illusions of material objects. As such, afterimages provide no more reason to reject representationalism (or purism more generally) than rainbows or shadows do.

At this point, it might be objected that Boghossian and Velleman also provide a positive argument, independent of considerations of materiality, that afterimages 'are not perceived as existing independently of being perceived'. The argument runs as follows.

On the one hand, the after-image is seen as located before one's eyes, rather than in one's mind, where visual memories are seen.... But on the other hand, one does not perceive these items as actually existing in the locations to which they are subjectively referred.... the after-image is seen as overlaying the thin air before one's eyes, where there is visibly nothing to see.... the image [is thus perceived] as a figment or projection of one's eyes: ... as existing only in so far as one is perceiving [it]. (1989: 87)

The only non-question begging ground offered here for the view that afterimages are perceived as mind-dependent entities is that 'the after-image is seen as overlaying the thin air before one's eyes, where there is visibly nothing to see'. However, if the claim here is that the afterimage is seen to be in a place where there literally appears to be *nothing*, then we should not accept it. As yet, we have no reason to deny that the *afterimage* appears there. If, on the other hand, the claim is that the afterimage is seen to be in a place where there is nothing *else* to see, then we should be nonplussed. Being co-located with some other visible object is hardly a necessary condition for not being perceived as mind-dependent. Raising the same basic idea later (*ibid.*: 93), Boghossian and Velleman ground the claim that 'you do not see [the afterimage] as something actually existing' at a specific location by appeal to the claim that 'you suffer no illusion about the nature of [the afterimage]'. This is precisely the claim disputed above. I conclude that their appeal to afterimagery relies solely on the fallacy there identified.

²¹ Hinton (1966: 363) suggests something like this view. Jones recognizes the affinities between afterimages, and rainbows, shadows and the sky. However, he goes too far, failing to recognize the many differences between these phenomena and after-images, not least that rainbows, shadows and the sky are all public, photographable objects. As a result he is led to make the extreme claim that 'after-images really do exist and are there in front of one's eyes' (1972: 155).

What lies behind Boghossian and Velleman's mistaken approach to the spatial presentation of afterimages? One possibility is that they are implicitly sensitive to the way that afterimages—being, as I have suggested, illusions of pure visibilia—do not appear such as to exclude other objects from the space they occupy. Arguably, material objects do appear to fill space in such a way as to exclude other objects from simultaneously occupying that space. Thus, by focusing exclusively on material objects it is not unnatural to run together spatial occupation with object-exclusion. As a result, the apparent failure of afterimages to exclude other objects from the place where they are located is liable to be misconstrued as a failure to appear to *occupy* the space where they are apparently presented. A second possibility is that Boghossian and Velleman are minded to contrast afterimages with other objects—both material and mere visibilia—on the basis that afterimages need not be presented as located at any determinate distance. This undoubtedly contrasts typical cases of seeing material objects as well as many pure visibilia. However, it is not plausible to hold that determinacy of presented distance marks a crucial boundary between the sensational and perceptual. For afterimages can be perceived as being at determinate distances from us, and ordinary objects can be seen without being presented as at any determinate distance.²²

The light illusion account also reveals what is wrong with other appeals to afterimagery. For example, in a recent discussion, Masrour (forthcoming) asks us to consider the complementary afterimage created by staring at the dot in the red box in Figure 2 for thirty seconds, and then fixating the dot in the uncoloured box.

'The afterimage,' writes Masrour, 'is not experienced as the colour of the page in the same way that the red colour is experienced as the colour of the red box; we do not experience it as an objective property of the page. The experience of the colour of the afterimage does not manifest phenomenal objectivity.' Masrour is of course right that there is a difference in the ways the two colours are experienced. But this difference does not entail, nor is it explained by, the claim that 'the colour of the afterimage does not manifest phenomenal objectivity'. What explains the difference between the red of the page and the bluish-green

²² For agreement on this last point and examples, see Smith 2002: 142–3 and Siegel 2010: 193–4. Note that Boghossian and Velleman quite rightly hold that afterimages *are* presented in space. If they were not, that might well be a ground on which to reject purism. But, as Moore writes: 'can anybody deny that each of these after-images can be quite properly said to have been "presented in space"?' (1939/1962: 130; cf. Smith 2002: Ch.5)

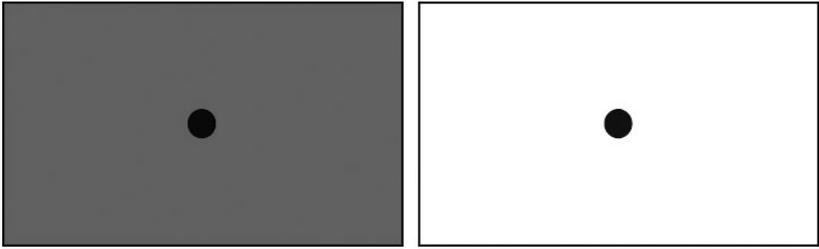


Figure 2. Based on Masrour forthcoming.

of the afterimage is that the latter is experienced as the colour of a *light* patch *on* the page, and not as the *ink* colour *of* the page.

5. Second Appearance: Eye-closure

A further contrast that Westphal (1991) notes between presentations of public objects and afterimages is that afterimages can be seen with closed eyes, whereas paint patches and the like cannot. Moore invariably appeals to *closed-eye* afterimages when giving examples of sense-data. Could it be the fact that afterimages can survive eye-closure which reveals their sensational nature?

It cannot be a general truth that closed-eye experiences are non-perceptual. For whilst closing our eyes obviously has dramatic effects on the light that impinges on the retina, as well as the processing of that stimulation, it is certainly possible to see things with our eyes closed. For example, we can see bright lights with closed-eyes, and sometimes we can see our eyelids, or other internal ('entoptic') phenomena. Furthermore, it is quite possible to hallucinate despite the fact that one's eyes are closed. And there is no reason to deny that these experiences should be counted as perceptual experiences (although of course not as genuine perceptions).

Perhaps the idea is that it is the failure of certain afterimages to *alter* appearance significantly despite closing one's eyes that reveals that they are merely sensational. In response to this suggestion we need to consider whether eye-closure is in itself an aspect of our visual experience. Closing our eyes clearly has effects on how things seem visually. Moreover, it may in some circumstances bring new objects (e.g., our eyelids) into view. However, when our eyes are closed it is not obvious that we are positively aware of our eyes as being closed except through non-visual means, most obviously through proprioception. In vision itself, we are plausibly aware only of the absence or diminution of light stimulation. Thus, if we continue to experience an afterimage despite closing our eyes, there is no clear reason to deny that we are simply under the

visual illusion that there is a light phenomenon before us when there is none.²³ In other words, when we close our eyes whilst enjoying an afterimage, there is no clear reason to deny that from a purely visual perspective it is as if the lights have gone off, leaving only the ‘self-illuminating’ image visible. It is important to recognize that this line of thought does not commit us to the implausible claim that simply closing our eyes creates the illusion that we are in darkness. Instead we might hold that we experience extended darkness when experiencing a closed-eye afterimage precisely because of the afterimage. Thus, in the absence of the afterimage, there need be no apparent awareness of a dark space beyond us, and so no illusion of engulfing darkness.²⁴

In sum, the fact that afterimages can be seen with closed eyes is notable only in that it partly explains why we are not deceived by closed-eye afterimages—since we typically know through proprioception that we have our eyes closed. However, if we confine our attention simply to the visual appearances, we can, for all that has been said, treat afterimages as apparent presentations of light phenomena in otherwise apparent darkness. Such appearances require no appeal to visual sensation, and no departure from purism.

6. Appearance Three: Size Constancy and Emmert’s Law

Constancy phenomena are often held to be distinctive of objective, perceptual representation.²⁵ It is unsurprising then that several of the appearances that sensationists allege of afterimages concern failures of visual constancies. The first alleged constancy failure to consider concerns the way afterimages alter their appearance with apparent distance. Such behaviour is described by Emmert’s law: the (eminently non-strict) law that the apparent size of an afterimage varies in *inverse* proportion to the apparent distance of the surface it is projected on to.

In a recent paper, Block connects this behaviour to a lack of ‘phenomenal objectivity’.

²³ The report (in Urist 1959) that closed-eye afterimages grow or shrink in conformity with Emmert’s law (see below) when subjects imagine converging on their fingers held before their eyes is suggestive in this context. It is natural to interpret it as showing that the visual system is still treating the afterimage as an aspect of the external environment even though subjects’ eyes are closed.

²⁴ This observation bears on subjects’ reactions to so-called ‘Swindle’s Ghost’-type images, noted below (§12.1), in which subjects sometimes insist that they can’t close their eyes even though their eyes are already closed.

²⁵ This traditional idea in perception science occupies centre-stage in Burge’s recent work (2009: 318f., 2010).

The change invoked by changing attention does not *look like a change in the world*—at least not to me.... these changes don't have what Burge (2009) calls the phenomenology of objectivity. The change looks unreal (to me). Its unreality is similar to the unreality in the way an afterimage grows and shrinks as the surface you project it on moves further away or closer.... (See any textbook on Emmert's Law, which describes this change of size.) But its growth looks somehow unreal or unobjective. The subjective unreality of these changes has not as far as I know received any empirical investigation. (2010: 53–4)

There is great deal of interest going on in this passage, but for present purposes what I want to focus on is the way that Block seemingly grounds his earlier claim that afterimages look 'unreal' or 'illusory' in the ways afterimages vary in size with changing distance according to Emmert's law. What should we make of this appeal?

The orthodox explanation of Emmert's law is that it is a direct corollary of size constancy narrowly understood.²⁶ The standard inference runs as follows. When an object of constant size recedes from us, its apparent size typically remains unaltered, despite the decrease in size of its retinal image (size constancy). Thus, if the size of a retinal image of an apparent object remains unaltered, despite an increase in apparent distance (as occurs with afterimages projected at varying distances), that object's apparent size will increase with distance (Emmert's law).

Block apparently takes Emmert's law to show that afterimages do *not* exhibit size constancy. Following Burge's association of objective representation with constancy phenomena, Block's suggestion appears to be that this grounds their lack of phenomenal objectivity. In one regard, Block is clearly right: afterimages do not appear to maintain their apparent size as apparent distance changes.²⁷ But what is less clear is why we should associate size constancy *in this narrow sense* with phenomenal objectivity, as opposed, for example, to associating objectivity with the broader phenomenon of size-distance scaling: the fact that apparent size varies in proportion to the product of retinal size and apparent distance. After all, it is size-distance scaling which captures

²⁶ This understanding follows Boring (1940). Emmert (1881) in fact focuses on real (not apparent) distance. Boring's understanding is correct: the relationship follows apparent distance (Dwyer et al. 1990). That said, there remains controversy concerning the exact status and explanation of Emmert's law (e.g., Lou 2007).

²⁷ *Ceteris paribus*: both size-constancy (with respect to ordinary objects) and Emmert's law (with respect to afterimages) break down in many ways and circumstances. For example, if you experience an afterimage of your hand in the dark, and then you move your hand towards you, the image may shrink in size as your hand gets closer. But it will not shrink below a certain limit, at which point Emmert's law fails. Commenting on this finding, Bross writes: 'the visual system "refuses" to size-scale the hand below a limit it accepts as representative or acceptable of "its" hand' (2000: 1385).

the broader fact that apparent size is not solely a function of retinal size but also of apparent distance; and it is this broader fact which captures what is really meant by 'size constancy' in many contexts.

This concern with arguing from a failure of size constancy in the narrow sense to a lack of objectivity can be brought out by considering the way psychologists tend to think of Emmert's law. Gregory, for instance, explains the law as follows: 'While the screen moves further away the after-image is seen expanding, as it is attributed to a receding object expanding to give the same-sized image.' (2008: 416) Here Gregory takes the natural explanation of Emmert's law to be that the after-image is being treated like an object by the visual system, and thus an object which is expanding.²⁸ This underpins the standard inference above: it is only because afterimages are being treated in the same manner as ordinary objects that we can legitimately reason from the size constancy behaviour of ordinary objects to Emmert's law regarding afterimages.²⁹ At the very least this should caution us against regarding failures of size constancy in the narrow sense as indicative of a lack of objectivity.

There is another, more intuitive way to see that Block's appeal to Emmert's law is too quick, namely by noting a simple elaboration of the light illusion account above which accommodates the behaviour of afterimages at changing distances. The clue to this elaboration comes from the fact that experiments on Emmert's law are often *not* conducted with afterimages (given the relative difficulty in sustaining them for long periods of time). Rather, a spot of light (or shadow) is projected onto a screen and viewed from the same distance as the projector. As Gregory notes, 'In either case the picture or shadow on the screen will double in size with each doubling of distance and yet, like

²⁸ Likewise Davies: '[Behaviour in conformity with Emmert's law] may be seen as a form of size constancy; under normal illumination the only way in which the same size of retinal image may be obtained from objects at different distances is for them to be objects of different sizes.' (1973b: 158)

²⁹ A nice illustration of this can be found in Crookes' discussion of Emmert's law in which he takes to task the standard inference from size constancy to Emmert's law just noted on the grounds that it 'assumes something which is not self-evident', namely that 'the perception of objects and of after-images are events of the same type, and must therefore follow the same law as far as apparent size goes'. According to Crookes, however, one 'cannot apply this deduction directly to after-images' since an 'after-image is not simply an object seen at a certain distance; it is recognized as something subjective, as being somehow a figment of one's sense-organs' (1959: 548). In other words, Crookes complains that deducing Emmert's law from the size constancy behaviour of ordinary objects presumes that afterimages are apparent presentations of ordinary objects as opposed to mere sensations. This is diametrically opposed to Block's appeal to Emmert's law which he takes to indicate the subjectivity of afterimagery.

an after-image, remain the same size in the eye' (2008: 415; see diagrams and discussion in Anstis et al. 1961). In short, afterimages obeying Emmert's law behave in just the way that *projected* light phenomena behave in certain circumstances. This suggests a natural embellishment of the light illusion account above: afterimages are illusory presentations of light phenomena which are typically experienced as though *projected from where we are located*. On this account of afterimages, the fact that they obey Emmert's law is neither unexpected, nor in any way suggestive of a lack of phenomenal objectivity.³⁰ We do not require visual sensation to make sense of the movies.

The first aim of the paper is now fulfilled. Ryle can rest easy. According to the light illusion account of afterimages just offered, afterimages are illusory presentations of light phenomena often apparently projected from the subject's point of view. In the next section, I argue that the light illusion account is not merely phenomenologically adequate but to be preferred to sensationalist accounts on empirical grounds.

7. Vision Science and the Light Illusion Account³¹

The light illusion account can be argued for in two distinct ways: the first traditionally philosophical, the second more empirical. The traditionally philosophical argument runs as follows. Afterimage experiences are indiscriminable from a certain kind of veridical perceptual experience, namely an experience in which we encounter a certain kind of light phenomenon projected from our own perspective. As a result, we should think of afterimage experiences as illusory presentations of such public scenes. That is, we should accept that afterimage experiences would count as veridical in the corresponding projected light scenarios.

This argument depends on two assumptions.³² The first assumption is that the relevant experiences of projected light should be treated as veridical experiences of public phenomena. An opponent could deny this assumption and instead insist that the indiscriminability of projected light arrays from afterimage experiences reveals a surprising fact about light projectors, namely that they are afterimage producing devices! The plain implausibility of this claim is a heavy burden for such an opponent to bear. The second assumption of the argument is a

³⁰ Note that Emmert's Law is not limited to afterimages; entoptic phenomena also obey the law (Gregory 2008). Such phenomena are both objective and located (and so apparently projected from) where we are.

³¹ I am especially grateful to Mike Martin for helping me clarify the argument in this section.

³² In addition to the indiscriminability claim itself. This is discussed further in §12.1.

principle concerning indiscriminability. The principle is that if an experience is indiscriminable from a veridical experience of some public feature of external reality, then that experience must itself be an experience as of such a feature. Whilst this principle is potentially open to question in its full generality, its local application is surely very plausible. A sensationalist who rejects the light illusion account by rejecting this principle must explain what non-question begging basis there is for doing so.

However, rather than pursue these matters, in this section I sketch an alternative way of arguing for the light illusion account, one which avoids any appeal to considerations of indiscriminability. This second argument appeals instead to constraints imposed from below, by vision science. Very broadly, vision science aims to establish general principles employed by the visual system, principles which govern how the visual system succeeds in extracting information from the light which registers on the eye so as to determine the nature of the visual scene a subject confronts. These principles allow the visual system to extract information concerning both material objects and also pure visibilia: shadows, rainbows and so forth. It is an obvious constraint on philosophical theorising about visual experience that such theorising not conflict with the principles that govern how the visual system responds to environmental stimulation. However, it is also a desideratum of such theorising that it mesh with the principles that govern the operation of the visual system in a way that respects general methodological principles of parsimony and simplicity. The light illusion account satisfies this desideratum; sensationalist accounts do not.

Afterimages, no less than ordinary perceptual experiences, do not occur at random. In both cases, their nature is closely related to the properties of the light registered by the eyes. Vision science aims to discover the principles which govern the visual system's response to such stimulation and serve to explain the subsequent generation of percepts. The light illusion account clearly respects the desideratum of satisfactorily meshing with the findings of vision science here. It does so by treating afterimages as the product of the very same kinds of principles already established to be at work in relation to the detection of pure visibilia (shadows, rainbows, etc.).³³ Indeed, we have already seen in the discussion of Emmert's law how the visual system appears to treat afterimages as if they were projected visibilia, and this fact was used to motivate a particular aspect of the light illusion account. In the remainder of the paper we will repeatedly encounter cases where it is

³³ For a recent interdisciplinary review of work on shadow perception see Dee and Santos 2011.

clear that the visual system is operating on the afterimage inducing light stimulus with principles appropriate to the detection of objects like projected lights and shadows.

In marked contrast, an account which supposes that there is some further and distinctive kind of sensational visual object (cf. Siegel 2010: 177 quoted above) generated on occasions when the eye is stimulated by light in such a way as to induce an afterimage, does not obviously have a way of respecting the constraint above. It cannot appeal to established principles, on pain of being driven to accept an account of afterimages such as that offered above. Thus, such an account is forced to postulate a novel and spandrel-like mode of operation of the visual system. As a result, even if the sensationalist sees fit to resist an argument based purely on the indiscriminability of afterimages from certain kinds of projected light phenomena, the light illusion account can be independently argued for on the basis that the sensationalist position fails to respect general principles of good scientific methodology. I return to this point below in the light of further empirical data.

8. The Traditional Marks of Mere Sensation

Above I listed six appearances allegedly possessed by afterimages, and alleged to be incompatible with purist accounts of visual experience. The light illusion account just defended demonstrates that the first three appearances are perfectly compatible with purism. I now turn to the second and final set of appearances that afterimages are alleged to possess. As I shortly demonstrate, afterimages do not in fact possess these appearances.

To introduce the final set of appearances consider the following passage from A. D. Smith:

[M]ovement of a sense-organ in relation to an object of awareness is wholly absent from the level of mere sensation, for such movement ... introduces *perspectives*. You cannot enjoy different perspectives on the inner-light show, or on any element of it; you cannot turn away from a headache.... Persons with cataracts can be credited with seeing objective photic phenomena because certain changes in the disposition of visual sensation will be consequent upon movements of their eyes. Even though a dark patch in such a subject's visual field will not be seen as at any distance from him, he will immediately take such a patch not to be a mere sensation, but something 'external' to him, because of the way in which movement of the operative sense-organ kinetically structures the sensory field. As the subject turns his head, the patch will occupy different parts of his visual field of vision, or will disappear from view, depending on the direction of his gaze. This

minimal ability to have different ‘perspectives’ on the object indicates that we have a case of perception, and not mere visual sensation. For none of this is true of the inner light-show, or of any other mere field of sensation. (2002: 142–3)

Here Smith gives flesh to the bones of the common idea that for an object to appear as a part of public, external reality there must be a distinction between how things apparently are with the object, and how things are with us.³⁴ Smith proposes three related ideas: that mere sensations appear such that we cannot move our eyes independently of them, that we cannot occlude or ‘turn away’ from them, and, most generally, that we cannot obtain different perspectives on them. Siegel, who endorses these key elements in Smith’s picture, calls these the traditional marks of mere sensation (2006: 371, 383; 2010: Ch.7; see also Langsam 2006).³⁵ In what follows I focus on Smith’s account, taking it to be representative of the tradition.

Leaving aside the question as to whether headaches fit Smith’s bill, the question of present concern is whether there are any *visual* sensations, and in particular whether afterimages should be classed as such. In other words at issue are claims (iv)–(vi) above.

- iv. Afterimages do not appear to exhibit kinetic independence/directional constancy.
- v. Afterimages do not appear to be occludable.
- vi. Afterimages do not appear to afford multiple perspectives.

The following three sections respectively demonstrate that afterimages lack these appearances. Afterimages do not possess the traditional marks of sensation. They are no enemy of purism.

³⁴ For different ways of thinking about this idea relevant to the present context, see Husserl 1989: §18b; Merleau-Ponty 2002; Strawson 1959; Evans 1980; Kalderon forthcoming.

³⁵ Siegel (2010: 175) begins her discussion by focusing on ‘entoptic phenomena traditionally classified as visual sensations, such as the experience of ‘seeing stars’ or of enjoying a red phosphene.’ Certainly vision science textbooks often include a chapter on ‘visual sensations’ or ‘entoptic phenomena’ with sub-sections on afterimages and phosphenes. However, note that according to the dictionary definition of ‘entoptic’, viz. ‘relating to the appearance of the different internal structures of the eye’ (OED), phosphenes and afterimages are not properly classified as entoptic, unlike floaters, Purkinje trees and so forth.

9. Appearance Four: Kinetic Independence

Consider first the claim that afterimages do not appear to move independently of the eye.³⁶ Note that the claim here concerns the *possibilities* for independent movement. It is certainly possible that throughout an object's existence it moves in perfect synchrony with a single observer's eyes. This is not simply because both eyes and object might be kept (apparently) still. Consider accurately pursuing a target against an otherwise homogeneous background, such as an empty field or sky. Here one will typically be able to detect the object's movement despite the fact that there is no change in retinal image, and no change in the appearance of the object relative to the homogenous visual background (cf. Mack 1970: 291). Insofar as such an object counts as perceptual (and surely it would be hard to deny that it ever can), it must on Smith's account be because of the *possibility* of moving the eyes independently of it. A similar point holds for the other two alleged appearances: the mere fact that an object is not occluded during its lifetime does not render it a mere sensation.

So we must ask: what are the possibilities for afterimage movement when we move our eyes? It seems doubtful that the full range of possibilities is something that we can easily ascertain via armchair introspection. Note for one that your eyes can certainly *be moved* independently of afterimages for it is only *active* as opposed to passive movements that typically generate afterimage movement (Wells 1792; Karrer and Stevens 1930; Urist 1959). Nonetheless, let us restrict Smith's claim to *voluntary* movement-independence. Can you voluntarily move your eyes independently of afterimages?

If the afterimage is of a large scene, then the answer is straightforwardly, 'yes'. As Pelz and Hayhoe report, 'large-scene afterimages do not appear to move with the eye but instead maintain a constant position with respect to the observer' (1995: 2269; Power 1983). What is more, if a small stationary light is also present in the visual field, then this light will seem to move with one's eyes as opposed to the apparently stationary afterimage. What this brings out is what Pelz and Hayhoe call a 'perceptual disposition to see the visual world as stationary' which can override even very significant information concerning eye-movements—information which is certainly available to the visual system in determining perceptual experience. In this respect, afterimages are not treated substantially differently from other aspects of the visual world: when they dominate the visual field, the presumption

³⁶ Smith claims that 'the most minimal presence of kinetic independence ... suffices for [genuine] perception' (2002: 173; cf. Siegel 2006: 370).

of their stationarity can induce illusory motion in ordinary small objects.

Though this fact about large-scene images is suggestive, it is not final. For one, it might be that *small* afterimages are kinetically dependent. How then do smaller images appear to move relative to our eyes? To investigate this, Grüsser et al. (1987) fixed subjects' heads still, induced a strong afterimage (at the dot marked 'L' in Figure 3), and instructed subjects to saccade steadily from side to side. These saccades were to be performed in synchrony with an auditory tone played alternately from two loudspeakers, one on the subject's right (LS1), the other on the subject's left (LS2). Subjects used a wand (C) to indicate how their afterimage appeared to move relative to LED reference points.

Grüsser et al. found that the afterimage(s) appeared in *four* basic ways according to the relative pace of the eye. These are tabulated in Table 1 below.

At every saccade speed, the afterimages exhibit kinetic independence. With slow eye-movements there is a lag (cf. Purkinje 1825). In this case, afterimages exhibit the same kind of momentum as floaters, of

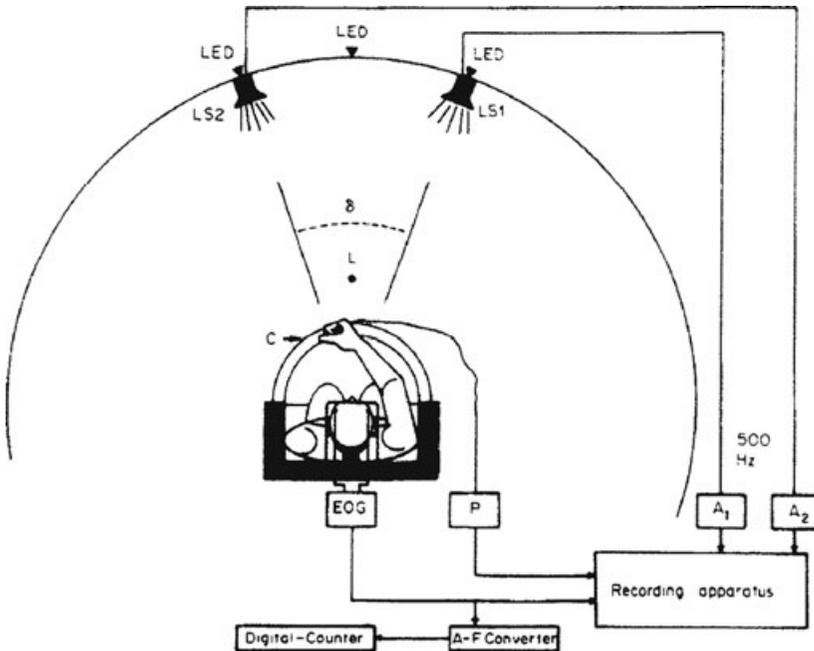


Figure 3. Reprinted from Grüsser et al. 1987:216, © Elsevier 1987, with permission from Elsevier.

TABLE 1.
Movements of Afterimages at Varying Saccade Rates (all quotations
from Grüsser et al. 1987).

Saccades per second	Phenomenology
< 1	Subjects observed ‘saccadic displacement of the ... afterimage, but the afterimage seemed to arrive at its final position more slowly than the centre of gaze’.
> 1.5	Subjects observed decreasing ‘perceived amplitude of afterimage displacement’.
> 2	‘[A]ll subjects perceived two stationary afterimages simultaneously at the saccadic end-position’.
> 3.2	‘A further increase in saccade frequency reduced the distance between the two afterimages till only one <i>stationary</i> afterimage was seen in a mid-position’.

which Smith comments, ‘[t]he minimal sense of objectivity that attaches to these derives wholly from the way in which their movements lag behind the movements of your eye’ (2002: 307, fn.13). Thus, by Smith’s own lights, afterimages exhibit kinetic independence with slow eye-movements. With faster eye-movements, the kinetic independence is more obvious. With rapid eye-movements, the afterimages do not appear to move at all. Thus, whilst it is true that afterimages do *often* move when we move our eyes, they exhibit nothing like the strict kinetic-dependence allegedly distinctive of sensations. Rather, they clearly exhibit various forms of kinetic independence. Despite their traditional classification then, afterimages do not exhibit this traditional mark of the merely sensational.

10. Appearance Five: Occlusion

What about occlusion? Are afterimages apparently impervious to efforts at occlusion as Smith and Siegel suggest sensations are?³⁷ Once again psychophysical experiments suggest otherwise. In a classic early study, Gregory and colleagues placed subjects in complete darkness broken only by a very brief afterimage-inducing flash. In one version of the experiment subjects held out their hands in the darkness so that the afterimage was initially projected on their hands. Subjects were then told to move their hands slowly back and forth. One possible effect of this is reported as follows.

The after-image may seem to remain fixed in space and to remain the same size. If the proprioceptive locus of the hand lies between the after-image and observer, the after-image may wholly or partially

³⁷ Smith claims that ‘[i]f ... occlusion really does make sense ... we should certainly be dealing with perceptual phenomena, and not mere sensations’ (2002: 301, fn.7; cf. Siegel 2006: 371).

disappear, as though occluded by an opaque object. (1959: 297; see also Davies 1973a; Cowan et al. 1998)

Smith might object to this counter-example that it involves projection, since, according to Smith, afterimages are mere sensations which 'become apparently normal objects of awareness for us only when 'projected' on to other objects ... the after-image merely serving to mislead us as to the characteristics of these objects' (2002: 193).³⁸ However, although the generation of the afterimage here involves very briefly illuminating the subject's hand, it is not clear that this amounts to projection in Smith's sense. After all, in the experiment, the images are principally experienced in the total darkness where there is no visible surface to project onto. Nonetheless, it is possible to finesse this worry, for there are cases of apparent occlusion which do not involve projection.

Normally, there are parts of the visual field that we cannot see without moving our head because they are in regions occluded by our nose, brow or cheeks. Following Hayhoe and Williams (1984), call such regions 'impossible locations in visual space'. Afterimages can appear to be occluded if they fall into such a region. As Hayhoe and Williams report:

The observer looks straight ahead, and an afterimage is induced by a bright flash falling near the lower edge of the visual field.... If the observer looks far enough down, the retinal region containing the afterimage is shadowed by the cheek, and the afterimage lies in an impossible location in visual space.... When we do this the afterimage vanishes. (1984: 455)

Hayhoe and Williams go on to note that 'the afterimage reappeared' when the observer looked up. On the face of it this all looks like precisely the kind of behaviour that it was claimed sensations must *not* exhibit according to the initial quotation from Smith above. Once again, afterimages lack this traditional mark of the merely sensational.

It might be objected at this point that, strictly speaking, we need not interpret the appearances of afterimagery in these cases in terms of occlusion. It is unclear, for example, why we should not think of the afterimage as being partially or wholly *destroyed* by the movement of the hand or eye (repudiating the apparent numerical identity of any afterimages said to 'reappear' on looking up again). Let it be conceded that these examples do not unequivocally demonstrate that afterimages

³⁸ Contrast Block's appeal to Emmert's law discussed above which focuses on the behaviour of afterimages when projected.

are occludable. Nonetheless, they undercut the sensationalist claim that it is simply obvious that apparent occlusion makes no sense with respect to afterimages. In the absence of further argument it is unclear what, apart from sensationalist prejudice, would commit us to excluding the possibility of apparently occluded afterimages from the start.

In this regard a further caution is worth noting. According to the light illusion account, afterimages are illusory presentations of projected light phenomena. The occlusion of projected light phenomena is different, and more complex, than the occlusion of material objects. Consider placing an object between a projector and the surface it is currently projected onto (imagine, e.g., walking in front of a cinema projector). In such a case, two things will happen. The intervening object will itself become a surface onto which the light is projected. And the intervening object will cast a shadow onto the surface originally projected onto. What this example reveals is that the typical refusal of an afterimage to be occluded by placing an object in front of the apparent point of projection is simply a further feature of the light illusion account. Insofar as the afterimage simply appears to be projected onto the surface of the intervening object, this is quite ordinary behaviour for projected light arrays.

If there are cases of genuine occlusion, these can be construed as cases in which the point of apparent projection is spatially separated from the observer's perspective, allowing for occlusion of the projected image from the observer's point of view. In accord with the discussion above, in any given case, the visual system will attempt to make best sense of the relevant input and our experience will be determined by the resultant interpretation.

11. Appearance Six: Multiple Perspectives

The work of Gregory and colleagues also shows that afterimages can appear such that one can take different perspectives on them.³⁹ We have, in the previous two sections, already seen examples of this with and without projection. However, if we bracket concerns about projection, a further striking example is worth noting.

When the observer changes his position in space, perspective changes may take place in the after-image. For example, an after-image may be obtained of a view down a long corridor. With the flash technique this will have unusual clarity. If the observer then walks across the corridor, looking down it, as it were, then his after-image may change

³⁹ Contra Smith 2002: 135; Siegel 2006: 356–7.

in perspective as he moves. (1959: 297–8; for a series of follow-up experiments see Davies 1973b; also Cowan et al. 1998)

What is going on here is that information concerning the subject's body position and movement is leading to changes in experience despite sameness of retinal image (cf. Bross 2000, noted above). Commenting on these and other similar findings Davies concludes against a purely photochemical account of afterimages as follows.

Afterimages are not 'pictures painted on the retina', static patterns of excited receptor cells dependent for their appearance and duration solely upon photochemical processes. They are subject to modification in both appearance and duration. The forms taken by the modifications in appearance are at least reminiscent of the well-known visual constancies, and are congruent with the notion of higher-level processing that integrates incoming information from all the sensory modalities. (1973b: 159)

Consideration of these and similar findings should also lead us to conclude against sensationalist accounts of afterimages. The visual processing of afterimage retinal input such as the integration of information from other modalities and subjection to a wide range of familiar constancy mechanisms makes plain that afterimages are treated by the visual system in much the same way that ordinary public objects of awareness are. Afterimages are no embarrassment to purism.

12. Objections

This penultimate section considers three natural objections to the argument above.

12.1. *Objection One: Obviousness*

The most common objection to the account developed above is to insist that it remains utterly *obvious* to us that afterimages are not aspects of the external world (see, e.g., Masrour forthcoming). Thus, even if afterimages don't appear as alleged, they certainly *do* appear to be illusory or unreal as Block contends.

No doubt it is usually obvious to us when we are experiencing afterimagery. However, there are quite mundane reasons why we do not regard afterimage experiences as having objective import. Our ordinary experiences are largely of a highly familiar and stable world. In contrast, armchair afterimages are typically feeble and fleeting. Afterimages are also typically experienced in full knowledge of their aetiology and the various counter-indications. Recall the afterimage induced by

staring at Figure 1 above. When you experience this image, you know that you have been staring for thirty seconds at a figure on the page in an attempt to generate an afterimage. When you experience it you also know that there are no Bob Dylan-esque holograms or strange lights floating around your office. You may also know that your eyes are closed. Finally, the image will, to a limited but significant degree, exhibit the marks of sensation that Smith alleges: it will tend to move when you move your eyes, and be difficult to occlude. In combination, these factors make it quite unsurprising that we do not feel any inclination to treat the experience as a genuine perceptual encounter with a publicly visible object.⁴⁰

A prediction of this view is that if we conspired to eliminate such mundane factors and background knowledge we might be inclined to treat an afterimage as a part of public reality. A prediction of opposing accounts, such as Block's and Masrour's, is that afterimages should never be mistaken for genuinely public objects. In this light, consider this remarkable passage from a famous early paper on afterimagery in which the author reports his and his subjects' astonishment at the vividness of their afterimagery.

I could scarcely convince myself that the light was not still burning; it seemed as if I could see my real hand, the real objects on my table and even the pictures on the wall. These decidedly positive after-images persisted for many seconds.... When I fixate with both eyes and then close them carefully after the last illumination, it is often difficult for me to believe that they are really closed. Observers often exclaim, 'My eyes won't shut,' 'I've lost control of my eyelids,' etc. This illusion is evidently due to the fact that the after-images, which have the same appearance, as far as colour and form are concerned, as the illuminated objects, are not only just as distinct as when the eyes are open but usually much more so.—Another very peculiar illusion is to be noticed when the observer, while being illuminated, fixates with only one eye, e.g., with the right one, and then opens also the left eye. It often seems as if through some painless procedure the left eye were being pulled out of the head. Some of the observers related their experiences in the following ways: 'I can't see with the eye that was closed,' 'I am blind in that eye,' 'It feels as though that eye were falling out,' 'I have a very peculiar sensation in that eye, but just what's happening to it I can't exactly say,' etc. (Swindle 1916: 329)

⁴⁰ There are doubtless other factors. One is that, as mentioned above, afterimages are often presented as being at highly indeterminate distances from us. But the removal of the usual depth cues can generate such indeterminacy in relation to ordinary objects without thereby creating any illusion.

The afterimages induced here are sometimes referred to as ‘Swindle’s Ghost’ images—Swindle suggests that such images were exploited by spiritualists to deceive their clients. They are rather special: to experience them one must be dark-adapted and the illumination on the retina must be highly localised, something which requires either a very brief flash or managing to keep one’s eyes extremely still. Nonetheless, such images serve to confirm the suggested prediction of the account of afterimages offered here, viz., that by removing familiar grounds for treating afterimages as mere illusions, they can deceive us, sometimes dramatically.

12.2. *Objection Two: Special Cases*

A second common objection is that a handful of laboratory experiments in which afterimages fail to exhibit the marks of the merely sensational hardly serve to refute the idea that *some* afterimages can exhibit such marks. It is of course tempting for the sensationalist to go further and claim that these ‘laboratory’ images are very special and provide no grounds at all for generalization. Both objections would be stronger if some ground for cordoning off these images, apart from their genesis in the laboratory, could be given. However, it is hard to see that what is distinctive about these afterimages (or the many others produced in similar experiments) should serve to discount them from the use to which they are put above.

Many experiments employ afterimages elicited by a very briefly flashed (c. 1 msec) high energy flash-tube. Some (but by no means all) use subjects who are dark-adapted for some minutes. The flash is brief to keep the eye effectively still during exposure to the light. In these circumstances, subjects enjoy afterimages of ‘great clarity and detail’ (Gregory et al. 1959: 297) which can last several minutes.⁴¹ Such afterimages do contrast with armchair images. However, this is plausibly a matter of degree (only a little ingenuity in a dark room with a bedside lamp is required to experience striking images at home). Moreover, far from leading us to discount them, the length and stability of laboratory images is what allows experimenter and subject sufficient time to inves-

⁴¹ In the movement experiments detailed above, for example, Grüsser et al. report that the ‘afterimage was seen in darkness for about 2–5 min’ (1987: 217). Psychology textbooks often include anecdotes of extremely prolonged afterimages. For example, Wade and Swanston (2001: 59) report one case involving a friend of Robert Boyle’s who, after, rather unwisely, staring at the sun through a telescope, still reported imagery some eleven years later. Wade and Swanston suggest that Boyle’s friend most likely destroyed his retinal cells resulting in a scotoma. But it is unclear why this should necessarily lead us to deny the claim that he could still experience afterimages.

tigate the ways in which afterimages really can and do appear. They are thus *superior* in one obvious respect to armchair afterimagery, given the use to which philosophers of perception wish afterimages to be put: they afford subjects the time carefully to reflect upon the appearances. Given also that these experiments are rigorously conducted by trained scientists using a number of subjects, it is tempting to place much *greater* weight on such reports than on those of individual philosophers.

Nonetheless, how can we rule out the possibility that *some* afterimages exhibit the appearances supposedly distinctive of the merely sensational? Moreover, wouldn't just *one* such case suffice to establish the reality of visual sensation? Though in the abstract this possibility must be admitted, the objection misses the force of the considerations above. Three points need making.

Firstly, as noted above, simply pointing to a case where we experience an afterimage which does not appear to move independently of the eye (or to be occluded) establishes nothing. The same might be true of a brief shadow cast by a light turned on, then off. What needs establishing is that the afterimage appeared such as to *preclude* apparent kinetic independence, or occlusion, or multiple perspectives. It is obscure how we could establish this without appeal to a substantial body of introspective evidence. Indeed it is obscure how we could establish this without appeal to psychophysical data.

Philosophers of perception are liable to assume that where our concerns are restricted to the appearances, we can ignore vision science. Appearances, after all, are available to us all, not just to scientists. Thus, in the same breath that Smith notes that what matters is how things seem and so 'the distinction between perceptual and merely sensory experience is one that needs to be made even for a 'brain in a vat';' Smith also avers: 'We are not here concerned with psychophysics' (2002: 142; cf. Robinson 2004: 4). Yet psychophysics is a source of immensely rich data as to how things seem to us. There is no tension here with the idea that positive claims about our experience must be grounded in introspective judgment. Such judgments are precisely what psychophysicists elicit under controlled conditions. Thus, if we are interested in the full range of possibilities of appearance, we cannot ignore the science.

Secondly, when we do turn to the experimental findings, they do not only cast doubt on the claim that *all* afterimages exhibit the marks of mere sensation; they also cast doubt on the claim that *any* do. Consider the experiment of Grüsser et al. The natural interpretation of this study is that *ordinary* afterimages move with the eye in a way which exhibits a significant degree of kinetic independence. Unless the sensationalist

can point to some special feature of the imagery here in question, it seems legitimate to treat this experiment as exploring how afterimages *in general* are able to move in relation to the eye. Similarly, consider the experiment conducted on afterimages and ‘impossible locations’ by Hayhoe and Williams. Since we all have heads which occlude parts of our visual field, this study is naturally interpreted as showing that afterimages *in general* can be apparently occluded in a certain way.⁴²

The third and final point connects to the argument for the light illusion account offered in section seven. This is that vision science aims not only to describe accurately our experiences, but also to establish the general principles governing the operation of the visual system which are responsible for our experiences. What the experimental findings concerning afterimages show is that afterimages are subject to the same basic principles (e.g., constancy mechanisms) as other visual input. In proposing that there are experiences which exhibit the marks of the sensational, Smith is in effect proposing that there are experiences which are the product of the visual system in a quite novel and unattested mode of operation. Such a mode cannot be ruled out in the abstract, but given what we know already, the generalisation of principles that are in fact incompatible with Smith’s position is surely the most parsimonious and scientifically respectable path to take.

12.3. *Objection Three: Phosphenes*

A final objection to consider is that the inner-light show is not simply a matter of afterimagery. Indeed, a number of writers (not least Smith and Siegel) emphasise *phosphene* experience as a central case of sensation. Perhaps phosphenes—as opposed to afterimages—are the real weapon in the sensationalist armoury.

This is not the place to engage this objection at length. That would require, in keeping with the discussion above, a detailed investigation of the possible ways phosphenes can in fact appear. Nonetheless, with due deference to future psychophysical findings, it seems likely that a phosphene-based objection to purism will fail in much the same way that the afterimage-based argument did. I say this because the limited psychophysical evidence available suggests that afterimages and phosphenes are close kin. (Indeed, their alternative name ‘evoked images’ suggests that the difference between the two kinds of experience is fundamentally causal not phenomenological.) Phosphenes obey Emmert’s law, for example (Covey and Walsh 2000). Moreover, Grüsser (unpubl. 1983, reported in Grüsser 1986: 17–18) relates an experiment in which

⁴² Perhaps not in all the ways in which ordinary objects can be; but can projected lights?

combinations of overlaid afterimages and phosphenes are produced in subjects, and that these move ‘absolutely synchronously’ in response to eye-movements. Given this kinship it would be surprising indeed to find that phosphenes appear in the ways that sensationalists have suggested afterimages do, given that afterimages do not. Moreover, it is unsurprising in this light that the limited data available on the kinetics of phosphenes suggests a complex relationship to eye-movements: certainly not the strict kinetic dependence Smith takes to be required of the merely sensational (see, e.g., Chapanis et al. 1973).

13. Conclusion

Afterimages are queer and curious phenomena, and in many ways their appearances are radically unlike those of the objects of ordinary perceptual experience. But we should not exaggerate the differences, nor build our metaphysics of perception upon them. Afterimages typically appear in ways that ordinary objects do not. Partly, this is because they are not illusions of medium-sized dry goods, but rather of projected light phenomena. Partly, this is because afterimages tend to behave in ways that neither tables nor shadows do. But this tendency is not an essential feature of afterimages, and nor is the opposing tendency an essential feature of ordinary objects. In particular, afterimages can appear to allow multiple perspectives to be taken on them, to be occluded, and to move (or remain stationary) independently of voluntary eye movements. In these ways afterimages show themselves to be governed by the same basic principles that govern the operation of the visual system in ordinary cases of perception. In short, afterimages exhibit the marks of the perceptual, not the merely sensational. In consequence, afterimages provide no reason to posit the existence of visual sensation, and so no reason to depart from purism. Of course, some other unusual kind of experience, or some quite different style of argument may force us to do so. There are many sensationalist arguments which I have not touched upon. Yet at least this is true: it is not Ryle who should feel embarrassed about afterimages.⁴³

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