

# PHILOSOPHY OF SCIENCE. FOR *THE* *ROUTLEDGE HANDBOOK* *OF PHILOSOPHY OF* *COLOUR*

M. CHIRIMUTA\*, MAY 2015 VERSION.

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## 1 INTRODUCTION

Why should philosophers of science be interested in colour? Why should philosophers of mind holding a specialist interest in colour concern themselves with the philosophy of science? This chapter aims to answer these questions by outlining the connections between problems in colour ontology and views concerning the metaphysics and epistemology of science. The problem of colour is often taken as a stand-in for the problem of the secondary qualities more generally. Yet the primary-secondary quality distinction cannot be understood without examining the way that the study of nature came to be conceived, in its modern form, during the so-called scientific revolution of the seventeenth century.<sup>1</sup> Thus the problem of colour

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\*Department of History and Philosophy of Science, University of Pittsburgh. mac289@pitt.edu

<sup>1</sup> "So-called" because many historians dispute the idea that the innovations of the seventeenth century can be considered revolutionary in the sense of a complete overturning of previous modes of investigation. Westman (2011), for example, prefers the term "early modern scientific movement".

ontology can be treated as a by-product of the modern scientific worldview, and it is an open possibility that a closer look at science will yield novel solutions to this problem.

### 1.1 The Two Images

One twentieth century philosopher much concerned to develop an integrated and historically informed approach to both sensory and scientific representation was Wilfrid Sellars. It is worth delineating some major themes from his writing on colour as a prelude to the core topics of this chapter. In his much discussed essay, “Philosophy and the Scientific Image of Man”, Sellars (1963) introduces the famous metaphor of the two images. The “manifest image” is the refined, common-sense account of ordinary objects, and also persons—their thoughts, feelings and perceptions—that has guided most philosophising in the Western tradition. One dominant feature of the manifest image is that sensations and perceptions are taken at face value. The pink appearance of a flamingo, seen in conditions in which no illusion or trickery are suspected, is explained by the fact that it *is* pink. The “scientific image”, which has begun more recently to loom on philosophical horizons, tends to view everything through a reductive lens, e.g. as “a swirl of physical particles, forces, and fields”. Since colours have no role to play in reductive or mechanistic explanation, the question arises as to how their very real presence in the manifest image can be reconciled with their absence from the scientific image. The challenge to philosophy is to fuse these conflicting images into a “stereoscopic view”.

Sellars argues that sensations, such as those of colour, present a particular difficulty for attempts to fuse the images by way of *identification*. The “homogeneity” of colour does not readily square with the particulate view of reality offered by the biological and physical sciences.

The trouble is, rather, that the feature which we referred to as ‘ultimate homogeneity’, and which characterizes the perceptible qualities of things, e.g. their colour, seems to be essentially lacking in the domain of the definable states of nerves and their interactions.

Nor do we wish to say that the ultimate homogeneity of the sensation of a red rectangle is a matter of each physical particle in the appropriate region of the cortex having a colour; for whatever other difficulties such a view would involve, it doesn’t make sense to say of the particles of physical theory that they are coloured. (Sellars, 1963, 35)

In essence, the contemporary debate over colour realism is a series of attempts to address the challenge of the two images. Physicalists hold, *pace* Sellars, that colours *can* be identified with certain properties figuring in physical explanation, such as spectral surface reflectance. Eliminativists, concur with Sellars in emphasising the mismatch between the colours, as they are grasped in the manifest image, and any physical reduction targets; but unlike Sellars they are nonplussed about the idea of just dropping the manifest image in favour of the scientific one, and eliminating colours from a revised ontology. The hallmark of primitivist theories is their insistence on taking the manifest image at face value. Reconciliation of the images will

happen, we are promised, through some clever theory of supervenience or non-reductive physicalism.<sup>2</sup>

One feature of Sellars' discussion is that he makes quite explicit a framing assumption that is often ignored by contemporary philosophers of colour. As he notes, "we are rejecting the view that the scientific image is a mere 'symbolic tool' for finding our way around in the manifest image" (Sellars, 1963, 36). In other words, the clash of the image occurs when scientific enquiry is interpreted as providing a representation of nature that is more true to reality than the picture given to us by sensory experience and common sense alone. This is to assume some version of ontological scientific realism—the belief that the entities posited by physics are the ones actually inhabiting our universe, and thus that the scientific image is a veridical one. This claim is by no means uncontroversial within the philosophy of science. For one thing, most realists within the philosophy of science endorse the weaker claim, that scientific theories *aim* at truth to nature, while their rivals urge that scientific theories are instruments for predicting phenomena and manipulating matter.<sup>3</sup> As Sellars also suggests, taking up an instrumentalist position in philosophy of science is itself one way to neutralise the problem of the clash of images. This is an option which has not so far been pursued within the recent colour debate.

## 1.2 Overview

In this chapter I will examine a series of topics which highlight the benefits of addressing the problem of colour from the vantage of philosophy of science, and vice versa. The task of Section 2 will be to unearth the links between the history of science and the problem of colour and the secondary qualities more generally. In Section 3 I will discuss Mark Wilson's critical re-evaluation of the primary-secondary distinction, which is itself informed by a complex view of scientific concepts and the way that they attach themselves to natural phenomena.

Section 4 moves towards the epistemology of science, and Ron Giere's influential theory of *scientific perspectivism*. In his presentation of perspectivism, Giere presents colour vision as the guiding metaphor for how different scientific models and theories offer us a patchwork set of varied views on the world. Finally, in Section 5 we consider the position of colour ontology, as currently practiced, within the broader currents of naturalised metaphysics.

## 2 PHILOSOPHY OF COLOUR AND THE HISTORY OF SCIENCE

### 2.1 Sensory Qualities and the Development of the Scientific Image

Hence I think that these tastes, odours, colours, etc., on the side of the object in which they seem to exist, are nothing else than mere names, but hold their residence solely in the sensitive body;

<sup>2</sup> See Hilbert and Byrne (chap. 8) on physicalism; Wright (chap. 12) on eliminativism; and Gert (chap. 9) on primitivism.

<sup>3</sup> E.g. Stanford (2006). See Chakravartty (2013) for a recent overview, and van Fraassen (1980) for an influential alternative to scientific realism.

so that if the animal were removed, every such quality would be abolished and annihilated. (Galileo, translated in [Burt \(2003, 85\)](#))

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This excerpt from *The Assayer* of 1632 is familiar to any readers of recent work in the philosophy of colour.<sup>4</sup> Galileo is readily interpreted as advocating a kind of anti-realist position, one which asserts that the colours—and other sensory qualities—are never instantiated except in the minds of perceivers. The question not so frequently discussed is why it should be that Galileo, a natural philosopher best known for his contributions to mathematical physics and astronomy, should be staking out such a position over the nature of mind and perception—what is the connection between his dismissive remarks on sensation and his new view of the heavens?

The first thing to note is that similar sentiments were expressed, on occasion, by many of the leading figures in seventeenth century natural philosophy, such as Descartes and Newton. For example, in the course of the 1704 presentation of his radical theory of the composition of light, [Newton \(1952, 124-5\)](#) remarks that:

if at any time I speak of Light and rays as coloured or endued with Colours, I would be understood to speak not philosophically and properly, but grossly, and accordingly to such Conceptions as vulgar People in seeing all these Experiments would be apt to frame. For the Rays to speak properly are not coloured.

A second point worth making is that this skepticism regarding the presence of colour in the world beyond our heads is the exact reversal of the dominant view of the scholastics whose Aristotelian natural philosophy prevailed in the era immediately preceding the early modern one. On the older account, the basic properties of matter—the qualities which were irreducible and had a primary explanatory role—could be listed as shape, the four elemental qualities (hot, cold, wet, dry), some “occult” qualities (e.g. the attraction to a lodestone), and the *proper sensibles* of each of the five senses ([Des Chene, 2006, 73-74](#)). These are the properties perceived by one sense alone, e.g. sound for hearing, heat for touch, and of course colour for vision.

In crude outline, this dramatic turnaround can be explained as resulting from the metaphysical demands of the new, mathematised and/or mechanised world picture. There is a vast literature on the so-called scientific revolution and the rise of mechanistic accounts of nature.<sup>5</sup> We may restrict our attention here to a few points most tied to the seventeenth century reappraisal of colour. The important thing about scholastic natural philosophy was that it proffered explanations in terms of numerous qualities, essences and powers, and there was no a priori restriction on how many of these might be at play in the world. The ontological profligacy of the Aristotelian system was disturbing for the mechanists. Those such as Gassendi, Descartes and Hobbes, sought to explain the same phenomena only in terms of a restricted set of qualities or properties belonging to the basic constituents of matter. The preference was to restrict the catalogue of properties to those amenable to geometric description or quantification.

For instance, Cartesians conceived of matter as “pure extension”, and so inferred that it could possess only the properties of size, shape, position

<sup>4</sup> This or similar passage is quoted by [Boghossian and Velleman \(1989, 81\)](#), [Thompson \(1995, 19\)](#), [Hilbert \(1987, 3\)](#) and [Giere \(2006a, 23\)](#).

<sup>5</sup> See e.g. [Gaukroger \(2006\)](#), [Henry \(2002\)](#), [Lindberg and Westman \(1990\)](#) for overviews.

and motion (Hatfield, 1990, 114). Boyle, a corpuscularian and leading experimenter of the day, took the defining properties of matter to be shape, size and mobility (Alexander, 1985, 70). Colours, and the other proper sensibles, formerly basic explanatory properties, were relegated to secondary status.<sup>6</sup> Boyle introduced the terminology of “primary” and “secondary” qualities, though the distinction was assumed by Galileo and Descartes before him, and is now most associated with Locke and his treatment of it in the *Essay Concerning Human Understanding*, published in 1690.

This is one of the ways in which Locke draws the primary-secondary distinction in the *Essay Concerning Human Understanding*:

Qualities thus considered in Bodies are: First such as are utterly inseparable from the body, in what state soever it be; such as in all the alterations and changes it suffers, all the force can be used upon it, it constantly keeps; and such as sense constantly finds in every particle of matter, which has bulk enough to be perceived; and the mind finds inseparable from every particle of matter, though less than to make itself singly be perceived by our senses. These I call *original* or *primary qualities* of body; which I think we may observe to produce simple *ideas* in us, viz. solidity, extension, figure, motion, or rest, and number.

Secondly, such *qualities*, which in truth are nothing in the objects themselves, but powers to produce various sensations in us by their *primary qualities*, i.e. by the bulk, figure, texture, and Motion of their insensible parts, as colours, sounds, tastes, etc. These I call *secondary Qualities*. (Locke, 1993, Book II, chap. 8, §§9-10)

The idea that primary qualities are inseparable from bodies dovetails with the idea that these qualities are the ingredients for all physical explanation. As Smith (1990) interprets the distinction, if a property were only occasionally present in matter, not belonging to all bodies at all times, it could not be as useful in a physics which aims to provide exhaustive explanations of natural phenomena via universal features and laws—to be a complete description of the world-machine. Thus one definition of the primary qualities is that they are universal. From this era we inherit a world picture, an informal ontology, of matter made up from miniature billiard balls which are colourless and odourless, but whose position and movements can be mapped by an exhaustive mathematical description. Thus we arrive at one popular version of the scientific image.

Another discernible legacy of the seventeenth century tradition is the tendency to extrapolate from physics to metaphysics. As Stebbing (1958, 64) remarks, the deniers of the reality of color have “made a metaphysic out of a method.” If one takes current scientific theories to be literally true accounts of the furniture of the world, as giving us our ontology on a plate, then the only hope for the reality of the manifest world of colour, taste and smell is that it somehow be shoehorned into physical nature. One familiar way to frame the contemporary colour debate is as a *location problem* (Jackson, 1998): are colours instantiated in ordinary material objects (realism), in the

<sup>6</sup> A point of interpretive controversy is whether colours are themselves to be identified with secondary qualities, or if colours are the ideas in us which are caused by secondary qualities (Alexander, 1985, chap. 8). In what follows, I attempt to avoid saying anything controversial about secondary qualities. Where necessary, I specify that the issue in question is the nature of “colour”, “sensation”, “perceptual experience”, as opposed to the nature of the secondary qualities.

minds or brains of perceivers (mentalism), or nowhere at all (eliminativism)? The very posing of the question assumes that we have a grip on what properties ordinary material objects have. We first assume that they are, uncontroversially, bearers of the primary (physical) qualities, and then go on to ponder the nature of the secondary qualities. In Section 3 we will consider reasons to think matters are not so straightforward for the primary qualities, and not so problematic for the secondary ones. Before that I will mention a few notable voices of discontent.

## 2.2 Unweaving the Rainbow

There was an awful rainbow once in heaven:  
 We know her woof, her texture; she is given  
 In the dull catalogue of common things.  
 Philosophy will clip an Angel's wings,  
 Conquer all mysteries by rule and line,  
 Empty the haunted air, and gnomèd mine—  
 Unweave a rainbow, as it erewhile made  
 The tender-person'd Lamia melt into a shade.

Excerpt from *Lamia* (1820). (Keats, 1982, 357)

Ironically enough, Keats's memorable phrase has been co-opted in the titles of at least two books whose aim has been to assert the explanatory supremacy of modern science.<sup>7</sup> Keats was not alone in considering reductive and physicalistic treatments of colour, like Newton's, to be emblematic of the poverty of the scientific worldview. In his prose musings Samuel Taylor Coleridge warns us against taking the scientific image on any more than instrumental terms, lest we mistake an abstract, monochrome sketch of the world for a true picture of reality:

In order to submit the various phenomena of moving bodies to geometrical constructions, we are under the necessity of abstracting from corporeal substance all of its positive [qualitative] properties, and obliged to consider bodies as differing from equal portions of space only by figure and mobility. And as a fiction of science, it would be difficult to overvalue this invention . . . But [scientists have] propounded it as truth of fact: and instead of a world created and filled with productive forces by the Almighty Fiat, left a lifeless machine whirled about by the dust of its own grinding.

Coleridge, *Aids to Reflection*, quoted in Wilson (2006, 76)

Thus science's threat to deny us the manifest truth of colour appearances has frequently been taken as symptomatic of the danger science poses not only to common sense, but to also to more humane or value-centred approaches to the world. This concern fired Goethe's notorious attack on the Newtonian theory of colour, resulting in the many pages of his *Farbenlehre* (von Goethe, 1989). While scientific posterity has taken a dim view of his attempt to provide empirical refutation of the thesis that white light is composed of the spectral hues, Goethe's 1810 treatise is a rich source of phenomenological observations of colour. In sum, it is worth remembering

<sup>7</sup> The full title of Hardin (1993) is *Color for Philosophers: Unweaving the Rainbow*. Alongside that book we have Dawkins (2000), *Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*.

that the scientific image, as method *and* metaphysics, has not always been taken at face value within recent intellectual history. Attitudes towards colour are indicative of wider beliefs about the nature and status of scientific enquiry, as is clearly illustrated in the case of the Romantics.

### 3 THE PRIMARY-SECONDARY DISTINCTION: WILSON'S DEFLATIONARY APPROACH

Mark Wilson's *Wandering Significance* is a recent work in the philosophy of science which deals extensively with the concept(s) of colour, and how they fit into scientific representations. Indeed, early on in the work, the question of the objectivity or subjectivity of colour and sound—the two most introspectively salient secondary qualities—is presented at length in order to motivate subsequent enquiry into the “conceptual behaviour” associated with a number of terms such as, “force”, “hardness”, and “red”.

Wilson (2006, 75-76) first entertains, and then rejects, the thesis of those such as the Romantics and Sellars who take science to provide way of describing nature which is fundamentally different from a common sense and sensory one. On his account, concerns about the elimination of colour from the scientific world view have their roots in “a false dichotomy between *objective* and *subjective* traits” (Wilson, 2006, 389)—in other words, in the assumptions that science deals only with a limited class of primary qualities, our concepts of which neatly correspond to mind-independent physical properties; and that science has no place for the secondary qualities, ones which appear to be in some sense response or mind-dependent.

In order to shake us out of our convictions about the sharpness and importance of the objective-subjective and primary-secondary distinctions, Wilson (2006, 6.ix) dwells at length on the puzzles surrounding the seemingly innocuous concept of “hardness”. Thomas Reid asserted that hardness was a straightforward primary quality, corresponding to the cohesion of the invisible parts of a body. Descartes, on the other hand, conceived of hardness as a response-dependent, secondary property, the disposition of a body to resist any pressure we exert on it, which we in turn associate with a specific sensation of hardness. Wilson's aim is to convince us that there is something wrong with both views. His central claim is that there is no *one* concept of “hardness” that orchestrates all of our various uses of the term. For instance, no one test of hardness (scratching, tapping, applying pressure) is appropriate for all the materials whose hardness we might want to assess, and no one physical characteristic, such as cohesion or rigidity of micro-structure, accounts for the hardness displayed by very different kinds of substances. Hardness can display a “multi-valuedness”—different tests of hardness can yield conflicting results as to the relative hardnesses of substances, and we would not have grounds to claim that either one of them is the true indicator. The upshot is that, “*hardness* proves to be neither a simple physical quantity nor a constant sensation, but an informational package with characteristics sui generis of its own” (Wilson, 2006, 351).

The next point is that colour and hardness are on precisely the same footing:

the predicate “red” is swayed by a swarm of multiple directivities and doesn't reflect any core unity at all. As with “hard-

ness," "red" (most of the time) conveys substantive physical information about its objects (roses, fire trucks, neon lights, etc.), but the nature of this information differs widely from target system to target system. The word's behavioral oddities stem from the same basic circumstances as engender those of "hardness": we lack the tools to settle a predicate of comparable utility on anything other than an uneven platform patched together through natural continuation. The mild inconveniences so occasioned do not greatly compromise the local objectivity of the physical information conveyed, but they do require us to take . . . precautions in working with claims about "redness" especially over a wider scale. (Wilson, 2006, 393)

Again, Wilson argues, our philosophical troubles stem from the assumption that there must be *one* governing concept of "redness" which accounts for all of our dealings with this term, one which has its source in a canonical sensation of redness. Instead, we have various ways of ascertaining the colours of objects, employing different and more or less exacting lighting and viewing conditions. Most of these assessments provide useful information about the physical nature of the object, and for different practical purposes some methods of colour "measuring" are more apt than others. For example, technologies of colour reproduction such as the manufacture of paints and dyes, require exact matching of pigments from one occasion to the next, so decontextualised viewing through reduction tubes is particularly useful. Those concerned with colour design must take into account surround contrast effects, so colours need to be seen in their intended context (Wilson, 2006, 456).

As with the case of hardness, the employment of different tests in different circumstances results in colour being a "multi-valued" property.<sup>8</sup> Philosophers have devoted much attention to perceptual variations involving colour—the fact that the apparent colour of an object can vary dramatically with lighting and surrounding conditions (e.g. Kalderon (2007), Cohen (2009)). According to Wilson, this is just a consequence of the patchwork nature of our colour concepts, the fact that what counts as "being brown" is defined only locally, that is, according to what viewing procedures are suitable for those kinds of occasions, and not in some universal, Platonic manner. He warns us against drawing any strong philosophical conclusions from perceptual variation:

one finds occasional squabbles about whether "brown is really a dark orange" in the color literature. But the fact that color talk commonly becomes multi-valued in this manner does not show that the data locally is not fully "objective," according to any reasonable construal of the term. (Wilson, 2006, 456)

So the bottom line of Wilson's discussion is that redness is as objective a property as others, such as hardness, whose place within the scientific image is uncontested.<sup>9</sup>

<sup>8</sup> The "multi-valuedness" idea entails a more radical pluralism than the conceptual dualism of Maund (1981) or Brown (2006). It would be interesting, though beyond the scope of this chapter, to compare these different views.

<sup>9</sup> Another helpful point of comparison is between colour and friction. Wilson (2006, 11) brings our attention to the disjunctive character of friction, while the reality of colour has often been called into question because the mapping between our concepts/experiences of colour and their physical causes is highly disjunctive (Jackson, 1998).

"So does *being red* represent an objective property or not?" The first observation we should make in this regard is that the predicate "is red" spreads itself over a rather complicated atlas of naturally connected sheets and locally corresponds to quite different forms of evaluations, to the degree that its target objects are not even of the same type ... But ... it manages to encode physical information quite nicely, albeit in a shifty and multi-valued way. True, the ways in which its parcels of usage piece together very much have the signature of human capacity written all over them, but that fact alone doesn't mean that the data entered upon those sheets has become thereby corrupted. (Wilson, 2006, 467)

Thus we must note that Wilson's notion of objectivity is very different from the one which colour realists typically aspire to. The metaphor of the atlas here is telling. Wilson often compares the locally defined use of a concept to a map, and the collection of concepts bound together under one word, such as "force", as an atlas. Maps are not regions of the Earth, but representations humans have devised in order to find their way around. As Wilson (2006, 6.ii) discusses at length, any projection of three dimensional geography onto a 2D surface involves distortion, and our practical intentions determine which distortions will be tolerated and where we must place a premium on more veridical projections. When I use my chromatic vision in order to assess the weather conditions that are indicated by the changing spectrum of the light I am tolerant of the colour *inconstancy* of material surfaces in a way that is completely at odds with the requirements for constancy placed when, for example, I try to find the best viewing conditions to look at fabric samples for new blinds. The different uses of colour, both in my perceptual experience and linguistic communications, are different processes for finding out about my surroundings but they are both, in some sense acknowledged by Wilson, human centred devices. In contrast, most colour realists have wanted colours to be simply part of fabric of the perceiver-independent world.

In short, Wilson employs his sophisticated account of scientific concepts in order to demonstrate the shakiness of the primary-secondary distinction. Once we drop any simplistic and naïve picture about how seemingly unproblematic scientific concepts attach themselves to natural phenomena, then the idea that colour causes *special* worries should disappear. But before moving on it is worth considering a disanalogy between colours and properties like hardness. While Wilson (2006, 396) is justifiably critical of the notion that there is one revelatory kind of perceptual experience which grounds our original grasping and subsequent use of a word like "red", it does seem fair to say that conscious sensory experience plays a role in chromatic conceptual behaviour which is not paralleled in the domain of hardness, friction, etc.. One way to parse Sellars' problem of the two images is as averting to the problem of consciousness itself: how could the homogeneous expanse of pinkness, of which I'm consciously aware, be accounted for by the reductive and mechanistic explanations offered by the scientific image? We might settle for a definition of hardness which only ever employs terms such as scratchability and resistance to external pressure, never invoking the *feeling* of indentation of an object on the skin; but an analogous definition of colour would seem to be missing something central. The challenge for Wilson would be to show that familiar worries about the development of abstraction in science (the mathematisation of the

world picture) casting out all “positive properties”, as Coleridge called the sensory qualities, are entirely unfounded. While Wilson (2006, 14) assures us that science *is* continuous with common sense thought, it remains to be seen if all the critical features of the manifest, sensory world can so easily be accommodated by science.

#### 4 COLOUR VISION AND SCIENTIFIC PERSPECTIVISM

In this section we examine the use of colour theory in Ronald Giere’s contribution to the debate over scientific realism. Giere’s *scientific perspectivism* asserts that,

the strongest claims a scientist can legitimately make are of a qualified, conditional form: “According to this highly confirmed theory (or reliable instrument), the world seems to be roughly such and such.” (Giere, 2006a, 5-6)

The view is intended as a *via media* between extreme versions of “objectivist” scientific realism (the thesis that theories can in principle provide “a complete and literally correct picture of the world itself” Giere (2006a, 6)) and constructivist anti-realism (“scientific claims about any reality beyond that of ordinary experience are merely social conventions” Giere (2006b, 26)). Giere employs colour vision as an analogue for scientific perspectivism:

Colors are real enough, but ...their reality is perspectival. And it is perspectival realism that provides us with a genuine alternative to both objectivist realism and social constructivism. (Giere, 2006a, 14)

So what does Giere mean by “perspectival realism”, and how does the notion apply both to vision and to science? I will first present the core idea and then ask whether the visual comparison does the required work in distinguishing perspectivism from standard versions of scientific realism and anti-realism.

In saying that colours have perspectival reality, the idea is that we cannot make any claims about what colour any object has without first specifying the perspective (the kind of chromatic visual system) from which the colour judgment is made. As such, perspectivism is a variant of *relationism*.<sup>10</sup> For example, Giere (2006a, 33) writes that, “[t]here is no color that the rug is “really”, that is, objectively. There is only the color of the rug as seen by a dichromat and the color a seen by a trichromat.” It follows that different perspectives are compatible: there cannot be genuine disagreement between divergent claims about the world when they are made from independent perspectives. Genuine disagreement is only possible from within one single perspective.<sup>11</sup> This feature of perspectival realism distinguishes it from objectivist realism. According to the latter view, there ought to be a perspective-independent fact of the matter about which colour judgment is the correct one.

Giere (2006a, 33-34) argues that the possibility of genuine disagreement and inter-subjective agreement from within a perspective prevents the encroachment of an “undesirable relativity”. Perspectivism is not an ‘anything goes’, overly permissive theory because enough individuals

<sup>10</sup> See Cohen, chap. 11 this volume

<sup>11</sup> Cf. Kalderon (2007); Kalderon, chap. 13 this volume.

happen to share a single perspective (e.g. a majority of humans are normal trichromats) such that their judgments are highly constrained.

Giere's central idea is that scientific theories, models and observations are perspectival in the same way that colour experiences, judgments and descriptions are. For example, the theories of classical and relativistic mechanics provide different perspectives on the motion of a body through space; the imaging techniques of PET and MRI offer neuroscientists contrasting perspectives on the brain, each suited to different empirical challenges. One disanalogy between the scientific and chromatic perspectives is that colour visual systems are fixed by genetic endowment and development. A dichromat cannot elect to take up the trichromatic view, and vice versa. On the other hand, scientists are typically trained to use a range of theoretical, observational and modelling perspectives, and gain facility in selecting the most useful mode to attack the problem in hand.<sup>12</sup>

Despite Giere's insistence on the distinctness of perspectivism, both scientific realists and anti-realists have argued that perspectivism collapses into one or other of the more traditional views. Before presenting these arguments, we should first note that the analogy between chromatic and scientific perspectives can be unpacked in three distinct ways:

1. **Partiality.** Just as no one individual or species is sensitive to all of the potentially visible wavelengths of electromagnetic radiation (Giere, 2006a, 35), no one theory or model (of a particular phenomenon) captures all of the potentially knowable details.
2. **Interestedness.** Just as the colour visual system of any particular species has been shaped during evolution by the needs and interests of that species (Giere, 2006a, 29), the theories and models of science are shaped the needs and goals of the scientific community and wider society.
3. **Interaction.** Just as colour phenomena are the result of an interaction between a perceiver and an external environment (Giere, 2006a, 31-32), science is the result of an interaction between human minds and activity on the one hand, and the natural world on the other.

As the citations indicate, Giere himself invokes all three of these senses of perspective at different points in the text. His critics, however, tend to focus in on just one or two of these point of comparison. For example, in his discussion of perspectivism, Chakravartty (2010) emphasises (1) partiality, invoking the spatial metaphor of different, restricted points of view. He writes that,

The idea of multiple perspectives does not by itself rule out the possibility that, quite independently of any given perspective on something, there are non-perspectival facts of the matter about it; neither does it rule out, by itself, the possibility that one might come to know what those facts are. . . .

Perspectivism becomes a philosophically controversial thesis, however, when one adds to the notion of perspective the notion that perspectival facts are all that can be known. (Chakravartty, 2010, 406)

<sup>12</sup> For this reason, Giere's notion of a scientific perspective has a narrower scope than the Kuhnian *paradigm*. A paradigm is a general world view which is pretty much fixed by scientific training. (Giere, 2006a, 82-83)

Accordingly, he next considers an argument for a philosophically controversial perspectivism which rests on the “partiality of detection”, concluding that the restricted range of the sensitivity of scientific instruments cuts no ice against the realist idea that there are knowable, perspective independent facts. Ultimately, (Chakravartty, 2010, 406) holds that, “even though there are thoroughly reasonable senses in which scientific models ... are perspectival, this does not entail that we do not or cannot learn non-perspectival facts relating to the things these models model.”<sup>13</sup>

On the other hand, Morrison (2011, 350) has recently argued that “perspectivism is simply a re-branded version of instrumentalism.” Instrumentalism is the anti-realist view that scientific theories and models are useful devices for predicting future occurrences of regular phenomena, but they should not be interpreted as providing knowledge of any deeper reality behind the appearances. Morrison’s argument rests on a case study of the current state of nuclear physics. Physicists employ over thirty models of the atomic nucleus and each is predictively powerful in some more or less restricted domain of application. Yet different models make radically different assumptions about the nature of the nucleus. Morrison urges that these different models should not all be considered as different, compatible perspectives on the nucleus because,

none of these “perspectives” can be claimed to “represent” the nucleus in even a quasi-realistic way since they all contradict each other on fundamental assumptions about dynamics and structure. ... [I]t becomes difficult to see how to interpret any of these models realistically since each is successful in accounting only for particular kinds of experimental evidence and provides very little in the way of theoretical understanding. (Morrison, 2011, 350)

In her assimilation of perspectivism to anti-realism, Morrison focusses on (2), the practical reasons for constructing different perspectives—the predictive power of the various models of the nucleus. Thus she does not explore the possible forms that representation of the nucleus might take for the different models. Morrison takes mutual inconsistency between models to rule out the interpretation of any of them as representing the nucleus.

To summarise, If we consider perspectivism along the lines of (1), the account is hospitable to a robust scientific realism. That is to say, each theory may capture a mere fragment of reality but is a true representation of that bit of reality nonetheless. On the other hand (2) is friendly to instrumentalist versions of anti-realism. If one emphasizes the interestedness of scientific investigation, it is tempting to take scientific theories to be essentially tools that are built in the service of particular practical ends. (3) puts the world beyond the investigator back in the picture, by asserting that scientific theories come about through sustained interactions with nature. This suggests that there is more to scientific theorising than a bare-bones instrumentalism would concede.

The interesting question is whether scientific perspectivism can simultaneously hold on to the different insights of (1), (2) and (3). This would best enable the theory to retain an identity distinct from both realism and anti-realism, while sharing some of the virtues of each. Elsewhere I

<sup>13</sup> Chakravartty does also consider a more robust version of perspectivism which emphasises interaction (“conditioning”), presenting an argument against any drawing of non-realist conclusions. In the interest of brevity I omit discussion here.

argue that the most promising route for the perspectivist here is to drop the visual metaphor in favour of a *haptic* one (Chirimuuta, raft). Because the sense of touch requires bodily contact and purposeful exploration on the part of the perceiver, it is obvious that with touch one apprehends an extra-dermal reality in virtue of and not in spite of its interactive and interested nature. By analogy, perspectivists should investigate the thesis that scientific representations inform us about the natural world *in virtue of* their interactive and interested qualities. The real break from traditional realism comes when one ceases to conceive of knowledge acquisition as the process of aligning inner representations to external state of affairs, a process which—on the traditional view—should ideally be uncontaminated by pragmatic concerns. But alongside the traditional realist, the perspectivist can hold that science in some sense yields knowledge of nature beyond the observable regularities.

## 5 PHILOSOPHY OF COLOUR AS NATURALISED METAPHYSICS

So far in this chapter I have only discussed colour in relation to general philosophy of science. I will now take up the issue of the relationship between philosophy and the particular sciences of colour, and consider the prospects for a naturalised ontology of colour akin to naturalistic theories in the metaphysics of substance, time, etc.. That is, I will ask to what extent philosophers who promote particular theories of colour can be said to be unpacking the ontological commitments of contemporary colour science.

### 5.1 A Spectrum of Views

The first thing to note is that there are various disciplines of colour science and that researchers who observe very different corners of the world, studying very different kinds of things, are all considered to be specialists in colour. Branches of colour science include:<sup>14</sup>

- Colorimetry and appearance modelling (Fairchild (2013), Wyszecki and Stiles (2000))
- Psychophysics (Hurvich (1981), Kaiser and Boynton (1996), Gegenfurtner et al. (2001))
- Computational modelling of constancy or discrimination (Gegenfurtner et al., 2001)
- Neurophysiology (Gegenfurtner et al., 2001)
- Genetics (Gegenfurtner et al., 2001)
- Optics (Wyszecki and Stiles, 2000)
- Chemistry of coloured materials (Nassau, 2001)
- Physics of coloured materials (Nassau, 2001)

<sup>14</sup> References in brackets are to key textbooks.

Note that no one discipline is held up as the “core”, the sine qua non of colour science, and there is a striking absence of antagonism between advocates of these very different approaches to colour. Curiously, scientists do not spend time worrying about how properly to locate colour, and quarrelling with those who locate it differently. It seems to be tacitly accepted that genuine colour science involves the ecumenical study of the various parts of nature that are all relevant to colour. But amongst this methodological diversity, is there any shared ontological commitment amongst colour scientists?

In a *Journal of Philosophy* article Hardin (2003, 191) writes that, “it is a curious sociological fact that many philosophers, but very few visual scientists, are color realists.” If we understand colour realism as the view that colours are perceiver independent properties that are instantiated on the surfaces of things, whether or not anybody is there to look, then the realist must hold that colour is in no way a by-product of neural activity. Thus in agreement with Hardin’s own anti-realism, some vision scientists have variously claimed that colour is identifiable with states of the brain, or that it is created or constructed by the brain. For example, Kuehni (1997, 26) writes that,

At this point in time our ideas concerning the nature of color are still largely speculative. For now, the most convincing account, in conflict with few if any facts, is that color is identical to a particular brain state.<sup>15</sup>

However, in making his sociological claim, Hardin is ignoring the numerous scientists working in the field of computational colour constancy who do express views akin to (but not identical to) physicalist varieties of realism. Maloney (2003, 285-286) reviews his colour constancy research and introduces the notion of “intrinsic colour”. He defines this as the “objective correlate of the perceived colour of a surface” which, he adds, could be measured by some computation of the surface’s reflectance. Like the colour physicalists Hilbert (1987, 65) and Tye (2000, 147-8), Maloney interprets the phenomenon of constancy as our perception of a stable colour property existing independently of us. In order to study how humans achieve colour constancy, it is fairly intuitive to frame the problem in a realist way: to say that colour constancy is about the recovery of a hypothetical objective property. This leads researchers to posit primary-like qualities—“intrinsic colours”—and then develop models of how these might be recovered. Yet as I have discussed elsewhere, this is not the *only* theoretical approach to constancy (Chirumuuta, 2008). So colour physicalism is not a compulsory commitment of colour constancy research, even though it does harmonise with some colour constancy models.<sup>16</sup>

Furthermore, the idea that colour is (at least in part) created or constructed by the brain *is* compatible with the group of theories known as colour relationism. The core relationist thesis is that colours are “constituted in terms of a relation between (*inter alia*) objects and subjects” (Cohen, 2009, 8), and one way to cash out this perceiver-dependence is in the idea that the brain has a role in “constructing” colour by partly governing how chromatic properties are perceptually manifest.<sup>17</sup>

<sup>15</sup> Cf. Sekuler and Blake (1985, 181) and Goldstein (1989, 140).

<sup>16</sup> But see Hurlbert (2013), a vision scientist who has recently argued that colour constancy research is *not* compatible with reflectance realism.

<sup>17</sup> This is the “interactionist” version of relationism that Giere (2006a) advocates, not the more familiar dispositionalist one. The interactionist view could also accommodate Wilson’s

Thus, as Giere (2006a, 32) observes, one of the textbook passages which is frequently quoted as an example of anti-realism is as much an expression of relationism: “There may be *light* of different wavelengths independent of an observer, but there is no *color* independent of an observer” (Palmer, 1999, 97). Palmer’s primary point here is that we cannot identify colour with a perceiver-independent physical property. This is, of course, in keeping with the relationist thesis that colour must be understood in terms of the relationship between perceivers (human or non-human) and objects. An anti-realist theory like Hardin’s only follows *if* one assumes that perceiver-dependence is incompatible with the reality of colour.

In short, we have seen that vision science presents no unified account of its ontological commitments. This supports Wilson’s claim that the various practical demands of different scientific sub-disciplines each push for a conception of colour that best suits the tasks in hand (Wilson, 2006, 456-457). If this picture is broadly correct, and if our only methodology is this rather direct reading off of theoretical commitments from the scientific literature, then the result will at best be a set of naturalised ontologies of colour. It would be disingenuous for a metaphysician of colour to present herself merely as an under-labourer excavating *the* conceptual foundations of contemporary colour science.

However, as I have argued recently, there are prospects for more synthetic approaches to the naturalistic metaphysics of colour (Chirimuuta, 2015, chapters 5-6). One pathway is to look for theoretical tensions within colour science, such as the need to account for the Janus-faced nature of colour—the way scientists must integrate physical and psychological causes of colour perception—and examine which ontology is most useful in this respect. Another avenue is to examine the very general theoretical framework of perceptual science—notions of perceptual representation, function and success—and see how the old philosophical debates about primary and secondary qualities appear when cast in those terms.

## 5.2 Empirical Science as a ‘Raw Material’ for Philosophy

Given the difficulties facing any attempt to develop a naturalistic philosophy of colour simply by reading off the ontological commitments of colour science, it is no surprise that philosophers have been pursuing alternative approaches. One productive strategy has been to mine specialized seams of experimental science which are rich in philosophical interest and relatively unexploited. In such cases we can think of empirical research as a raw material for philosophical enquiry—a source of constraints on proposed theories and counter-examples to commonly held intuitions. In addition, work in naturalistic philosophy of colour is sometimes said to originate more directly from current scientific knowledge and to be guided more closely by the demands of science. Another avenue is for philosophers to conduct experimental work in tandem with non-empirical theorizing. I will give examples of each strategy, noting that there are many more cases to be found in the published literature.

The science of colour constancy has long figured in philosophical debates,<sup>18</sup> with many holding that consistency with constancy phenomena, and with their scientific explanation, is a non-negotiable requirement on

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conceptual pluralism if we include cognitive, information-gathering processes into the notion of interaction.

<sup>18</sup> See Brown, chap. 18 this volume, and references therein.

any metaphysical theory of colour. In contrast, the phenomenology and psychology of transparency and perceptual *scission*—the experience of coloured surfaces and volumes as layered one on top of another—has been relatively neglected by philosophers. An exception is recent work by Derek Brown, who presents an account of colour layering as a means to reassess the dispute over the extent to which the supposed experiences of constancy are actually characterised by chromatic variability (Brown, 2014), and to evaluate the force of the variability argument for colour relationism (Brown, 2015). Here, experimental psychology serves as an inspiration for alternative accounts of constancy and variability experiences, and as prompt to examine different kinds of phenomena which go beyond the stock examples.

The fact that a significant proportion of the male population has a dichromatic, rather than trichromatic visual system is often mentioned in passing as one amongst many types of perceptual variability. Broackes (2010) dwells at length on the complex phenomenology associated with dichromacy and anomalous trichromacy, in order to address the question “what do the colour-blind see?”. Presenting his own analysis of surface-light interactions, and proposals for new psychophysical experiments, Broackes challenges the dominant scientific explanations of colour-blindness.<sup>19</sup> Synaesthesia is another fairly common source of atypical colour experience. Brogaard’s research on the topic has combined experimental investigation (e.g. fMRI, Brogaard et al. (2013)) and modelling (Brogaard et al., 2014), while Brogaard (2015) discusses some implications for colour ontology.<sup>20</sup>

Johnson and Wright (2006, 140) make explicit their methodological requirement that a theory of colour should be shaped directly by scientific concerns. They write that,

a metaphysical theory of color that is designed to be of use in the sciences should be driven largely (or perhaps entirely) by considerations of what the various sciences need in order to proceed appropriately.

They offer a Quinean indispensability argument for colour realism, noting that colours have an essential role to play in explanations in the special sciences (as opposed to fundamental physics). They also point out that standard arguments against colour realism, ones which focus on the mismatch between physical descriptions of the world and manifest colour appearances, tacitly assume that it should be possible to reduce the causes of particular colour experiences to physical kinds (p.151). While Johnson and Wright consider just the fact that colors are multiply-realized from the perspective of physics (and the attendant worries for physicalist colour ontologies), it is worth considering if their proposal also undercuts the Sellarsian claims for the incompatibility of the scientific and manifest images. It seems so, to the extent that Sellars (1963) demands a smooth reducibility of theories and kinds in psychology to neurophysiology, and thence to chemistry and ultimately physics. Sellars does not seem to consider that special science kinds may have novel properties, like homogeneity, which do not feature at more fundamental levels; or at least, as Davies (2014) argues, that there may be epistemic barriers to our understanding how such novel properties arise from the fundamental physical structure of the world.

<sup>19</sup> See also Broackes, chap. 19 this volume

<sup>20</sup> See also Brogaard, chap. 25 this volume

### 5.3 Conclusion

A theme of this chapter has been that the philosophy of colour, viewed through the lens of philosophy of science, must resign itself to a quite radical pluralism of concepts, theories and methodologies. The payoff of pluralism is that it promises to resolve the clash between Sellars' two images. On Wilson's account there is nothing especially problematic about fitting the concept of red into the scientific image, so long as we appreciate that the concept behaves differently depending on the uses to which it will be put. Giere's perspectivism entails that there is no one unified scientific picture of the world, and this makes it unproblematic to accommodate special science properties and kinds which cannot be reduced to fundamental physics.

As I have hoped to show in this chapter, there is much to be gained from marrying the philosophies of science and colour. One may rightly worry, though, that union will turn out to be a rocky one. What if the ties between the philosophy of colour and other branches of philosophy—ones concerned with the analysis of everyday language, and the nature of mental representation—place conflicting demands on theorising about colour, such that no (fairly) unified account can be expected to satisfy the requirements of semantics, psycho-semantics, and science, all at once? In the end, a restrained methodological pluralism seems reasonable. It is worth heeding Wilson's lesson that we have various concepts of colour, which serve different masters; that does not mean that the philosophy of colour need become entirely fragmented. There is scope for a productive interplay between naturalistic approaches to colour and the traditions more based in the philosophy of mind and language, so long as the different theoretical aims of these projects do not become muddled.<sup>21</sup>

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