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Colour Eliminativism or Colour Relativism?

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A Re-Reading of C. L. Hardin's *Color for Philosophers: Unweaving the Rainbow*, Indianapolis: Hackett Pub. Co., 1988*

Larry Hardin's *Color for Philosophers* marked a shift in philosophers' approach to and interest in colours. Prior to the release of the book the majority of philosophers concerned with the nature of colours were proposing theories without an eye to colour science. With its detailed outline of the current state of colour science and the neural and experiential realization of colour, *Color for Philosophers* filled a critical gap in the literature.

The empirical focus in colour philosophy keeps gaining momentum, with many new empirically-based theories entering the scene. However, in the last decade or so colour philosophers appear to have lost sight of the relevance of the neural and experiential realization of colour to the nature of colour. A popular focus has been on how to give an account of colour that is independent of colour perception. I believe this turn in colour philosophy is unfortunate, as some of the most interesting attributes of colour are inseparable from experience.

Hardin's book still offers one of the most comprehensive and accessible coverages of the neural and experiential realization of colour and its relevance to the metaphysics of colour. As such I think it is worthwhile to take a second close look at Hardin's case for the relevance

* Editor's Note: 'Re-Readings' is a regular feature in *Philosophical Papers*. Authors are invited to write on a past article, book, or book chapter that they deem, for whatever reason, to deserve renewed attention. Authors are encouraged, where appropriate, to discuss the work's reception by and influence upon the philosophical community.

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of what goes on in the brain and what it is like to see colour to what colour is. I will begin with a review of Hardin's arguments for the relevance of cortical colour processing to colour metaphysics. I will then go over the main problems some of these insights raise for theories of colour that take human perceivers to be irrelevant to the nature of colour. Finally, I will outline an alternative to Hardin's view which inherits its virtues while avoiding its disadvantages.

A scientific theory crucial to the stance of Hardin's book is the Hering-Hurvich-Jameson opponent-process theory. This theory explains the colours in terms of how the brain interprets the signals from the cones and rods in the retina. The cones respond to chromatic (coloured) daylight, whereas the rods respond to achromatic (black-white) nightlight. We normally have three cone types: L (red), M (green) and S (blue). Together they support three opponent channels manifested in bipolar cells that receive information from the cone cells. The bipolar cells measure differences between red (L) and green (M), blue and yellow (differences between L plus M and S) and black and white (the sum of L and M). For example, when green dominates, red is inhibited; so the result is green. Likewise, when the activity of the S cone is greater than the joint activity of the L and M cones, the result is blue. The opponent-process theory can explain many of the properties Hardin takes to be necessary features of colour, for example, the feature of red that it is opposed to green and the feature of blue that it is opposed to yellow.

The opponent-process theory only explains the human visual system's ability to detect wavelengths; it does not explain conscious representation of colours. People with blindsight, a kind of residual vision in the absence of a functional primary visual cortex, can detect wavelengths but they have no conscious experience of colours (Stoerig and Cowey 1992; Hardin 1985: xxx). Likewise, people with achromatopsia, a condition resulting from a defect to the V4/V8 colour complex that inhibits chromatic colour vision, have no conscious hue experience (Heywood, Kentridge and Cowey 2001, Heywood and Kentridge 2003). Conscious perception of the full range of colours apparently requires double-opponent processes in V1 and the V4/V8 colour complex. Double-opponent processes measure the differences in luminance or colour between two neighboring areas of the scene. Double-opponent cells in the V4/V8 colour complex, for example, may detect that the L cone is stimulated more than the M cone in one area but that the M cone is stimulated more than the L cone in a neighbouring area. This would represent a red-green colour contrast, that is, a transition from red to green.

While one of the aims of Hardin's book is to provide an introduction to colour science aimed at philosophers, the book also argues for colour eliminativism (or what Hardin calls 'subjectivism') partially by arguing against the most salient contenders. According to Hardin, despite the fact that we experience colours, no objects have colours. Our chromatic perceptual states are the result of neurophysiological events and do not correctly represent objects as coloured. All colour experiences, he argues, are illusory.

One of the more radical contenders to Hardin's theory is physicalism about colour. This view has been defended, among others, by David Hilbert (1987) a couple of years after the publication of *Color for Philosophers* and by Alex Byrne and Hilbert (2003) several years later in an influential target article in *Behavioural and Brain Sciences*. David Armstrong and Michael Tye have also been avid advocates of colour physicalism (see e.g., Armstrong 1961, Armstrong 1968 and Tye 2000).

Most colour physicalists take colour tokens to be surface spectral reflectance properties. A surface spectral reflectance property is the percentage of the light at each wavelength across the visible spectrum that is reflected by a surface.

Hardin cites the problem of metameric matches as one of the main phenomena against physicalism and in favour of eliminativism. Metamers are objects with different surface spectral reflectance properties that appear to have the same colour under certain sorts of illumination. For example, a surface that has a peek in reflectance at 500 nm and a second peek at 650 nm gives rise to the same green colour appearance in daylight as a surface with a peek in reflectance around 550 nm. A version of physicalism that takes the colours to be surface spectral reflectance properties cannot explain this, as it would predict that metamers should have different colours.

The colour-opponent process theory provides a straightforward explanation of metameric matches. When there is a metameric match, it is due to fact that each object triggers very similar neurophysiological processes in the brain. The reason that metamers trigger similar neurophysiological processes is that the brain processes wavelengths as ratios of excitation of cones in the retina. Any two surfaces that stimulate the three cone types in the same ratios will give rise to experiences of the same hue (Hardin 1985: 44). For example, monochromatic light of 580 nm and a mixture of light of 540 nm and 670 nm can both trigger an experience of unique yellow, a yellow that is neither reddish nor greenish, as long as the ratio of excitation of the cones is the same.

Hilbert (1987) and Hilbert and Byrne (2003) avoid the problem of metamers by denying that colour types (e.g., red, yellow, green and blue) are surface spectral reflectance properties. The colour types, they say, are sets of these surface spectral reflectance properties. So, metamers whose spectral properties correspond to those to monochromatic light of 580 nm and a mixture of light of 540 nm and 670 nm have the same colour, viz. unique yellow, because their reflectance properties belong to the same reflectance type, viz. that for unique yellow.

Hardin, however, thinks that this sort of response introduces more problems than it solves. For example, it does not explain why there is a unique yellow but not a unique orange, that is, one that is neither reddish nor yellowish. The latter problem does not go away simply by assuming that the reflectance types red and yellow are sets with members in common, viz. the orange members. If physicalism is true, physical description alone must imply that it is possible for there to be a unique yellow but impossible for there to be a unique orange. As Hardin puts it:

> If yellow is identical with G, and orange is identical with H, it must be possible for there to be a unique G but impossible for there to be a unique H.

> If hues are physical complexes, those physical complexes must admit of a division into unique and binary complexes. No matter how gerrymandered the physical complex that is to be identical with the hues, it must have this fourfold structure, and, if objectivism is to be sustained, once the complex is identified, it must be possible to characterize that structure on the basis of physical predicates alone. (1985: 66)

A further problem for physicalism is that of accounting for the colours of light, air and water (Hardin 1985: xxiv-xxv). When the sky is blue, it is because only the shorter wavelengths of light are absorbed by the gas molecules and scattered in all directions. This is also known as the 'Rayleigh scattering'. Given that surface spectral reflectance properties are properties of surfaces, it would seem that the physicalist is forced to say that light, air and water do not have colours. But if they do not, then obviously true colour attributions, such as 'the sky is blue', said on a bright summer day, turn out to be false. This deprives physicalism of one of its advantages, viz. its ability to grant that colour talk has meaningful truth-conditions. One way to solve this problem would be to introduce surfaces where there is none. Another is to bite the bullet and say that only surfaces have colours.

Edward Averill (1992) and Mohan Matthen (1988) argue that the latter sort of move is consistent with biological adaptation. The biological function of human vision, they say, is to recover the surface spectral reflectance properties of objects. However, as Hardin points out, this is not quite right. It is important for us to be able to recover spectral properties of light, air and water. This sort of detection ability likely has played a crucial role in our evolutionary progress. Hardin notes that the human eye, in fact, has the highest degree of sensitivity to the average wavelength of light at a forest floor, suggesting that the ability to detect the spectral properties of light has had a greater evolutionary advantage than the ability to detect the spectral properties of surfaces (Hardin xxv).

Hardin's theory, of course, has no problem explaining the greenish-blueness of the ocean or the blueness of the sky. When the sky and, say, a shirt are both experienced as blue, this is due to the fact that very similar neurophysiological events are taking place in the brain. More precisely, in both cases the activity of the S cone is greater than the joint activity of the L and M cones.

Spectral reflectance properties and colours come apart in a number of other ways. First, there are spectral reflectance properties that do not correspond to any regularly instantiated human colours; for instance, the reflectance properties of ultraviolet light. This observation by itself does not necessarily present a problem for physicalism, as the claim that the colours are identical to sets of surface spectral reflectance properties does not entail that every set of surface spectral reflectance properties is a human colour. However, there is another problem for the physicalist in the vicinity. As the human lens absorbs ultraviolet light, most individuals cannot see light in this range of the colour spectrum. However, there is evidence to suggest that individuals who have had cataract surgery, which consist in the removal of the lens, can interpret light in the near ultraviolet range of the colour spectrum (Stark 1987 and Stark, *et al.* 1994). The condition is also called 'aphakia'. Light in this range gives rise to a desaturated (or white) blue experience because, while all three cones in the human eye are sensitive to ultraviolet light, the blue cone is more sensitive to light in this range than the other two. If Byrne and Hilbert were to extend their solution to the problem of metamers to this case, then the colour type blue would be a set of reflectance properties some of which correspond to ultraviolet light. The resultant view, however, would be a radical deviation from physicalism. The only thing that would make this set identical to blue would be that it happens to bear some causal relation to human colour experience that is subjectively describable as 'blue'. As this solution is not available to the physicalist, the only other option is to say that when blue experiences of people with aphakia are caused by ultraviolet light, they are illusory, and this is so, despite the fact that there is a non-deviant causal relation between these experiences and ultraviolet light.

Second, even leaving aside the colours of air, light, water and other chemical substances, there are colours that are not relevantly causally connected to any set of surface spectral reflectance properties. An example of this is the so-called Martian colours perceived by some synesthetes, particularly colour blind synesthetes (Ramachandran and Hubbard 2003). As these kinds of synesthetic colours are never instantiated, there is no set of surface spectral reflectance properties that regularly triggers them.

Another example of colours not relevantly causally connected to any set of surface spectral reflectance properties comes from cases of colour imagery. There is empirical evidence that colour experience can have a neural correlate in cortical regions outside of the visual cortex, suggesting that the represented colours are not relevantly causally connected to any set of surface spectral reflectance properties. For example, visual imagery may be a result of activity located exclusively in the temporal, parietal and frontal brain regions (Brogaard, *et al*. 2012). There is also evidence to indicate that individuals without colour vision are capable of experiencing colour imagery. Cortically blind individuals sometimes report having colour imagery, despite being incapable of visual perception (Chatterjee and Southwood 1995). This suggests that colour imagery can be recalled from memory without any associated visual cortical activity. Insofar as memory requires activation of cortical brain regions, these data indicate that cortical regions outside of the visual cortex are implicated in colour computation.

A third example of colours not relevantly causally connected to any set of surface spectral reflectance properties is that of reddish-green and bluish-yellow. That reddish-green and bluish-yellow can be experienced was first demonstrated by Hewitt D. Crane and Thomas P. Piantanida (1983). The stimulus was adjacent red and green stripes (or blue and yellow stripes); when the stimulus was held in the same position relative to the participants' eyes, some of the subjects experienced reddish-green or bluish-yellow. The study was successfully repeated by Vincent Billock, Gerald Gleason and Brian Tsou (2001), who also adjusted for luminance variation. Despite the fact that some subjects can experience reddish-green and bluish-yellow, these shades of colour have no instantiated physical colour correlates.

This apparent dissociation between the colours and surface spectral reflectance properties suggests that the colours are not identical to surface spectral reflectance properties.

Perhaps the greatest challenge for physicalism is that of explaining differences in colour perception among individuals who pass normality tests. What some individuals experience as unique green, others experience as bluish-green or yellowish-green (Kuehni 2001; Malkoc, *et al*. 2005). Another example of variability is that among normal Caucasian males, who fall into two types of perceivers that differ in terms of their average peak responses to red light. In one study, the difference in average peak response to red light between the two groups was found to be 5 nm (Winderickx, *et al*. 1992). There may even be individual and gender-based variation in focal and peripheral colour experience (Murray *et al*. 2012).

There are also data that suggest that some individuals, for instance the mothers and daughters of dichromats, or colourblind individuals, experience colours that no normal perceivers can experience (Jameson 2007). Dichromats are almost always men. In most cases the colour disturbances are due to a defect to a red or green photo receptor gene on the X chromosome. If the dichromat inherited the defective gene from his mother or passes it onto his daughter, then it is possible for mother and daughter to express both a defective and an intact red or green photo receptor. As cone types are defined by photo receptors, some of these women are tetrachromats—they have four cone types. Having four cone types does not imply enhanced colour vision. The brain must be able to interpret the signals coming from them. But studies have shown that tetrachromats sometimes do see colours that normal people do not see (Jameson, *et al*. 2001; Jameson *et al*. 2006).

I agree with Hardin that it is difficult for colour physicalism to account for individual and group variation in colour perception. Alex Byrne and David Hilbert claim that it is very simple to accommodate the variability data: Whenever two individuals disagree about the colour of an object, at least one of them is wrong (Byrne 2006). As there are no independent physical criteria for the identity of hues, Byrne and Hilbert's view entails that there are unknowable colour facts. So, this sort of response entails a kind of epistemicism about colour. In numerous cases it is impossible to discover who (if any) is right about the colour of an object. For any object, there presumably are two individuals who disagree about its colour on the basis of normal perception. So the colour of every object is unknown. I find this view extremely puzzling.

Because the greatest disagreement among individuals concerns unique green, Averill (1992) proposes to solve the problem of disagreement by denying that there is a colour that deserves the label 'unique green'. As he puts it: 'The boundaries of yellow and blue overlap in the vague (or fuzzy) part of their boundaries. So, there are no (colour equivalence) classes that define unique green'. On this view, then, while there is bluish-green and yellowish-green, there is no green untainted by blue or yellow. In this respect green is no different from orange. I agree with Hardin, however, that this view strides against our concept of what green is (1985: xxiv). It is conceptually impossible to visualize an orange untainted by red or yellow but quite straightforward to visualize a green untainted by blue and yellow.

Unlike physicalism and other forms of objectivism, Hardin's view can easily explain the individual differences in colour perception. Individual differences are due to differences in the neurophysiological events triggered by the incoming stimuli. The differences in the neurophysiological events, in turn, are due to genetic differences in cone photopigments.

Hardin's theory, however, is not without its problems. One of the greatest challenges for eliminativist theories is that of explaining colour constancy.[1] The expression 'colour constancy' refers to the constancy of colours over different illumination conditions. For example, I see the

1 Peter W. Ross (2012) raises an interesting objection to subjectivism, the problem of perceived location. Subjectivists, he argues, cannot account for why colours nearly always are perceived as being located. Colour relativism, as defended below, avoids this problem, as it can account for colours as located relative to a point of view.

grass outside my window as having a constant colour despite the different inputs I receive visually when I look at it in the morning, at noon and late in the afternoon as the sun is setting. Colour constancy normally is taken to support objectivist theories of colour. Some will say that the visual system is designed through adaptation to gauge objective properties of objects, such as geometrical and topological properties. Hardin's explanation of colour constancy turns on noticing that colour constancy is approximate only, and that colour constancy also occurs in cases in which no colours are instantiated. For example, we might visualize a scene in which the illumination conditions are changing during an outside family gathering without it appearing as if the grass changes colours during the visualized time span.

However, it is not clear to me how saying that colour constancies are approximate and also occur in the case of purely subjective colours gets colour eliminativism off the hook. It seems to be a fact that when we do see objects as having the same colour in different illumination conditions, we are tracking physical properties of objects. Even when we are merely visualizing objects as having the same colour in different illumination conditions, this probably depends on our ability to track the physical properties of objects.

One solution to the problem, which Hardin hints at in the 'Afterthought' to the second edition of *Color for Philosophers*, is to grant that our visual system very often does track physical properties of objects but deny that the physical properties our visual system tracks are the colours (1985: xxxv).

However, once we admit that our visual system has adapted the ability to track physical features of objects that correlate with the colours we perceive, the claim that objects do not have colours starts to look really suspect.

Colour eliminativism, however, is not the only possible way of accommodating variation data and other data that speak against physicalism and in favour of eliminativism. An alternative to eliminativism is colour relativism. Colour relativism holds that colours are centred properties. Centred properties are features that can be instantiated and have extensions only relative to a centred world in which a perceiver and a viewing condition are marked. The version of colour relativism I have defended on previous occasions takes the colours to be primitive centred properties, the representational equivalents of phenomenal colour properties (see e.g., Brogaard 2010). The colours, as I envisage them, are just the colours Hardin is interested in, viz. the unique hues red, yellow, green and blue as well as black and white and colours describable by the unique hues and modifiers such as 'deep' and 'vivid' (Hardin 1983: xxi). Each of the chromatic colours has a unique location in colour space, and they bear well-known relations to each other. Like Hardin, I would deny that the colours are properties of sense data or even experiences. When colours are experienced, they are components of the propositional contents of perceptual experiences, just like the shapes and textures we experience perceptually.

My disagreement with Hardin concerns primarily the question of whether colours can be instantiated. On the view I prefer, objects can instantiate colours relative to a perceiver and a set of viewing conditions. To be red is to give rise to a certain appearance of redness (given a perceiver and a set of viewing conditions). It is due to this perceiver-dependence of the instantiations of colours that the colours do not have a place in physical theories. Physical theories are primarily concerned with properties that can be instantiated independently of perceivers. Redness in this respect is just like tallness. The property of being tall does not figure in physical theories. And there is no objective fact about whether an object is tall or not. To be tall is to have a certain height that is beyond average given a comparison class. But objects can nonetheless possess the property of being tall.

Both the colour eliminativist and the colour relativist can do justice to the science but traditional philosophical considerations give us reasons to prefer relativism to eliminativism. One reason to prefer colour relativism to colour eliminativism is that it gives us less incentive to be sceptical of the claim that colours exist. On Hardin's view, colours exist in colour space as abstract universals. On the traditional view of properties, properties just are abstract universals. But traditionally, these abstract universals have been thought to define intensions, or functions from possible scenarios to extensions. In fact, it is hard to make sense of what a property is if it does not define such a function. On Hardin's view, colours could not be instantiated independently of opponent processes. In scenarios without creatures like us, there are no colours, and in scenarios with creatures like us, colours are not instantiated. So, Hardin's view implies that there are no scenarios in which colours are instantiated. Colours then do not define functions from scenarios to extensions, which is to say, colours cannot be understood as properties. Hardin, it seems, owes us a story about exactly what colours are. Colour relativists do not face the same problem. Though they must deny that colours define functions from possible worlds to extensions, they can grant that colours define functions from centred worlds to extensions. It may, of course, be complained that centred properties are not properties. There are, however, good reasons to think that centred properties are properties. Centred properties are constituents of centred contents. And, as I have argued in previous work, centred contents play the theoretical roles propositions have traditionally been thought to play (Brogaard 2012).

A second reason to prefer colour relativism to colour eliminativism is that it offers a way of distinguishing between veridical colour experiences and illusions. Colour eliminativism entails that all colour experiences are illusory; but intuitively, there is a difference between the colour experience associated with a red piece of paper and the colour experience associated with a white piece of paper illuminated by red light (see Chalmers 2006 for an interesting response to this problem). Given colour relativism, some colour experiences are veridical and some are not. The fact that colours sometimes track physical properties of objects provides a natural criterion for whether a colour experience is veridical or not. Colour experiences are veridical when their colours are non-deviantly caused by physical properties of external objects that can trigger colour experiences; otherwise they are falsidical. The external physical properties in question sometimes are surface spectral reflectance properties and sometimes spectral properties of light, air, water and other chemical substances.

There is a third alternative to colour eliminativism that also accommodates the variability data and the other data in favour of eliminativism, viz. colour relationalism. According to Jonathan Cohen (2009), who has provided the most comprehensive defence of the position to date, colour relationalism is the view that colours are relations to perceivers and viewing conditions. Like colour relativism, colour relationalism grants that things have colours and that there are veridical experiences that are distinct from illusory experiences. Colour relationalism is neutral on the nature of the perceiver-dependent relation. One natural version of colour relationalism would be a form of colour dispositionalism that takes colours to be the disposition to cause colour experiences of a certain kind in particular perceivers under particular viewing conditions. This form of colour dispositionalism differs from more traditional forms insofar as it treats the relevant dispositions as relations to particular perceivers and viewing conditions rather than relations to normal perceivers and normal viewing conditions.

The main reason that I prefer colour relativism to colour relationalism is that I think colour relationalism requires us to reject a version of representationalism that I find exceedingly plausible. The version I have in mind says that phenomenal character determines phenomenal content. Call this position 'weak representationalism'. If weak representationalism is true, then colour relativism appears to be false. The argument runs as follows (Brogaard 2012: Chapter 8):

1. You and I can have identical phenomenal colour experiences.
2. Weak representationalism is true.
3. So, you and I can have colour experiences with the same content.

The first premise seems intuitively plausible. Even though you and I have different visual systems, it seems plausible that we could be having phenomenally indistinguishable colour experiences, perhaps by viewing the very same scene at two different times. But colour relationalism would hold that colours are relations to perceivers. So, if your colour experience represents colours, then you (or a description of you) are part of the content of your experience, and if my colour experience represents colours, then I (or a description of me) am part of the content of my experience. So, our experiences appear to have different contents, which is inconsistent with (3). The relationalist then must reject a very plausible version of representationalism or deny that you and I could have identical colour experiences. Both options seem implausible.

Colour relativism allows us to hold onto both weak representationalism and the assumption that you and I can have phenomenally indistinguishable colour experiences. Furthermore, like colour objectivism, colour relativism can explain the intuition that the colours represented in experience sometimes are instantiated by physical objects relative to a perceiver and a viewing condition. Colour relativism, however, has several advantages compared to traditional forms of colour objectivism. Like colour eliminativism, it can appeal to colour-opponent processes in explaining why green is a unique colour, whereas orange is not, why no object is reddish-green, why metamers give rise to the same colour experiences and why some colours have no relevant causal connection to external physical properties.

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