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Color, Mental Location, and the Visual Field

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Color subjectivism is the view that color properties are mental properties of our visual sensations, perhaps identical with properties of neural states, and that nothing except visual sensations and other mental states exhibits color properties. Color physicalism, by contrast, holds that colors are exclusively properties of visible physical objects and processes.

C. L. Hardin (1990, 1993) and others have argued that the phenomenon of metamerism demonstrates that color physicalism is mistaken. Peter W. Ross (2001) rejects these arguments, since they rely on the corresponding category constraint, which he urges is unfounded. He also sees that constraint as turning on a philosophical, rather than a scientific, issue. Ross goes on to argue that color subjectivism is indefensible, since no version of it provides an acceptable theory of perception. Since Ross holds, with Hardin, that the only alternatives are color physicalism and color subjectivism, Ross concludes that we must instead adopt some version of color physicalism. He urges that a version he calls disjunctive physicalism is defensible.

I agree with the spirit of Ross's rejection of arguments against color physicalism based on metamerism, though I urge a different way of casting the issues. I do this in Section 1. In Section 2, I raise some questions about one of Ross's arguments against color subjectivism. And in Section 3, I conclude by arguing that his rejection of color subjectivism does not give us reason to endorse color physicalism. The reason is that there is a third view, on which there are two distinct types of property we classify as color properties, one mental and the other physical. On this double-property theory, we must distinguish between the physical color properties that characterize visible physical objects and processes and the mental color qualities that characterize visual sensations. Since we count both types of property as color properties, neither color physicalism nor color subjectivism is defensible.

1. Metamerism and Color Physicalism

Metamers are objects with distinct spectral reflectance properties which nonetheless look to us to have exactly the same color. This happens because the color an

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object looks to us to have depends on how wavelengths reflected from that object activate each of the three types of light-sensitive element in the daylight visual system. Any particular spectral reflectance of an object activates to some degree each of the three types of cone cells in the human retina. And the color an object looks to us to have is a function not of the spectral reflectance itself, but of the ratio of activation of those three light-sensitive elements that the spectral reflectance results in.

Since colors result not from specific wavelengths but from such ratios of activation, humans see many combinations of wavelength as the same color, since many combinations will produce the same ratio of activation of the three types of cone cell. Given any specified condition of illumination, different reflectance properties of objects will result in the same ratio and, hence, will be seen as the same color. Objects look to humans to have the same color in clear, midday sunlight if, in that illumination, they result in the same ratio of cone activation. In different illumination, these same spectral reflectance properties might well result in very different activation ratios, and so look to us to have different color properties.

One cannot, accordingly, identify the colors of physical objects with spectral reflectances, since objects we count on commonsense grounds as having the same color have different spectral reflectances. These considerations do not, however, preclude identifying the colors of physical objects with suitable *ratios* of the reflectance properties of visible objects. Physical color properties are equivalence classes of reflectance properties, where the defining equivalence relation is specified in terms of such ratios. This appeal to equivalence classes is perfectly in order. Any properties with which we might identify colors must be sorted in some suitable way. Though sorting reflectance properties by specific wavelengths will not do, sorting them by ratios of wavelengths will.

One might object that we cannot determine what the relevant ratios are by reference to anything about the physical objects themselves. Instead, the relevant ratios must be fixed by reference to the properties of the human visual system. True enough, but that does not mean that the resulting properties are not wholly objective, nor that those properties are not physical. Physical objects absorb and reflect visible light in characteristic ways, and each reflectance profile determines some ratio relevant to the human daylight visual system. Though we classify these reflectance profiles by reference to that visual system, the profiles we classify are all strictly physical. So the properties that result from this classification are wholly objective, physical properties.

Put differently, identify the properties this classification yields with sets of reflectance properties under the equivalence relation of yielding the same ratio of cone excitations. Every member of these sets is physical, and methods of sorting these do introduce nothing nonphysical. Indeed, no reference to the human visual system is necessary, since we can capture the excitation potential of any reflectance property in strictly physical terms.

Although the properties of producing the right ratio are strictly physical, it should not be surprising that reference to the human visual system is needed in picking these properties out. We classify commonsense color properties in the first place, themselves by reference to the abilities humans have visually to differentiate and to register similarities, abilities that vary from one species to another. So any physical

properties with which we might identify commonsense color properties will have to be picked out by reference to the human visual system as well. Still, the way we pick something out need not indicate anything about its nature.

Ross would presumably find the foregoing congenial, but takes it to amount to a kind of disjunctive physicalism. I am not sure things are best described that way. Taking standard illumination as fixed, the ratios in question correspond one-to-one to commonsense colors; they are in no way disjunctive. Of course, each color corresponds to a range of reflectance profiles, but that is because each ratio can result from a range of reflectance profiles. Whether some property is disjunctive often depends on the level of analysis from which we approach it. The physical properties we identify colors with are disjunctive if we take specific reflectance profiles as basic, not if we take ratios as basic.

Compare this situation to definitions of mental states in terms of their functional roles. Functionalist theories of mind define mental states in terms of their characteristic causal relations with stimuli, behavior, and other states, themselves defined in such terms (Lewis, 1972). A specific functional role defines each type of mental state. But bodily states with widely divergent physical properties might well satisfy the same functional description; each functional definition is multiply realizable, relative to physical types. Such an account of mental-state types is disjunctive only relative to bodily states classified physically, but not relative to states sorted by way of functional role. Similarly a physicalist account of color properties is disjunctive only relative to specific reflectance properties, not relative to activation ratios.

These considerations, which I assume would be congenial to Ross, have implications for the corresponding category constraint and color physicalism. That constraint provides that whatever physicalist properties we identify colors with must correspond with our ordinary color categories and explain them. Reflectance properties defined by specific wavelengths fail that test, but ratios of reflectance properties satisfy it. Such ratios both correspond with and explain our ordinary color categories; so we can identify physical colors with reflectance properties defined not by specific wavelengths but by suitable ratios of wavelengths. And, since this treatment of colors is physicalist, the corresponding category constraint does not preclude color physicalism.

Ross understands the corresponding category constraint as requiring that physical colors be physical kinds, and he would presumably follow Hardin and others in denying that sets of reflectance properties defined by relevant ratios fit that bill. But why? Considerations proper to physics will not yield the relevant ratios; in that sense the ratios match no physical kinds, that is, no kinds determined by physics alone. On that test, color physicalism is indeed indefensible. But biological and chemical kinds are also not determined by physics alone, and undoubtedly they are physical in a perfectly suitable sense. We should not deny physical status to a kind solely because it is not required for physics; physical kinds are *kinds that can be defined in terms of physics.* This lets in biological and chemical kinds, as it must, and also lets in reflectance properties sorted by the relevant ratios.

Ross describes the corresponding category constraint as a substantive philosophical assumption, which we can adopt or reject independently of scientific theorizing. One might question whether any tenable line can, after all, be drawn between scientific

and philosophical considerations. But even apart from such general concerns, the corresponding category constraint is best seen as having reasonably firm scientific footing. The constraint is arguably just a special case of the sound methodological principle that, when we identify commonsense, macroscopic properties with microproperties, those microproperties should correspond with and explain our ordinary commonsense, macroscopic categories. And that principle is a sound regulative ideal for theoretical identifications; though it may not be met in every case, it is a sound goal for scientific theorizing. So the corresponding category constraint is best seen as a regulative goal that guides scientific identifications, not a substantive assumption, philosophical or otherwise.

2. Spatial Qualities and the Visual Field

Having argued that his disjunctive version of color physicalism is defensible, Ross goes on to argue that that color subjectivism is not, since no version of color subjectivism provides an acceptable theory of perception. Restricting attention here to the adverbial version of color subjectivism, I argue that the considerations Ross raises against that version can be satisfactorily met. If so, color subjectivism survives Ross's argument.

Adverbial subjectivism construes color as an aspect of the way a person or other animal senses visually. Red is a matter of a person's sensing in a red manner—sensing redly, as adverbialists say. Adverbial subjectivism treats the sensed-location properties of visual sensations the same way. When one visually senses red as being off to the left in one's visual field, one senses in a red manner and in an off-to-the-left manner: redly and off-to-the-left-ly. It is this treatment of the sensed-location properties of visual sensations which Ross, following Austen Clark (1996, 2000), believes causes trouble.

Ross illustrates the problem he sees in connection with visually sensing a red circle inside a green square. Adverbial subjectivism characterizes this in terms of an array of sensory events to which the adverbs 'redly,' 'circularly,' 'greenly,' 'squarely,' and 'insidely' apply. But according to Ross, adverbial subjectivism cannot accommodate this case because it cannot capture what it is for the one event of sensing to be sensed as being inside the other. This is the location problem of Ross's title.

But adverbial subjectivism can accommodate this case. The adverbial subjectivist will describe the case as involving two sensory events, one occurring redly and circularly and the other occurring greenly and squarely. In addition, the first event occurs insidely with respect to the second. There is no difficulty in adverbially characterizing events one event relative to another. You and I may both run swiftly, but it may also be that you run more swiftly than I; we characterize your event of running as occurring more swiftly than mine. Similarly, we can say that the sensory event that occurs redly and circularly also occurs insidely with respect to the sensory event that occurs greenly and squarely. 'Insidely' is, in this way, a relative adverb. There are issues about the logical form of descriptions involving adverbs, but no reason to think that such relative adverbs are any more problematic than standard one-place adverbs.

On adverbial subjectivism, every adverbial color characterization can apply to sensory events that occur in any part of the visual field; events anywhere in the visual

field could be redly or greenly. Ross argues that, since adverbial subjectivism treats sensed-location properties the same way, every sensed-location adverb can characterize sensory events anywhere in the visual field. But sensed-location properties pertain to where a sensory event occurs in the visual field. Ross concludes that adverbial subjectivism cannot be correct in treating sensed-location properties and color properties the same way.

But things are more complex. Consider the adverbial characterization of a sensory event as occurring to-the-left-ly with respect to some other event. The adverb 'to-the-left-of-ly' can apply to pairs of sensory events that occur almost anywhere in the visual field. But there are limits; some events in the visual field occur to the left of any other sensory event. These are events that occur at the rightmost edge of the visual field and so cannot occur to the left of any other event. Such considerations fix the boundaries of the visual field, and thus the mental space that defines the field. Sensory events can then be individuated by reference to where they occur in the mental space so determined, in effect starting at the boundaries and working inward. Relative sensed-location properties, such as occurring to-the-left-of-ly, suffice to fix the sensed location of visual events.

Introspectively, it seems as though we first fix the subjective center of the visual field and then work outward, and this is another possibility. We might for example, fix such a subjective center of the visual field by reference to the sensed location to which attention is naturally drawn, using sensed-location properties such as occurring to-the-left-of-ly to impose sense spatial structure on the rest of the field. What matters is that we can handle sensed location by treating mental properties pertaining to sensed location as the subjectivist treats mental color qualities.

Ross, however, believes that we cannot identify particular parts of the visual field by reference to mental qualities that pertain to location, and so concludes that we must instead identify those parts by reference to the physical locations we sense. We must identify positions in the visual field by way of relations the perceiver bears to perceived physical objects that occupy various physical locations. But spatial mental qualities, such as the mental quality of being to the left of, do impose a spatial structure on the visual field and thereby individuate positions in that field. We need not appeal to the physical objects and physical locations we sense to individuate positions in the visual field.

In addition to imposing a grid on the visual field, thereby solving the problem about the relative locations sensations in that field, there is also an issue about how locations in the visual field match up with the physical locations we perceive. Some such match is needed for any visual perceiving to occur. And it may well be this problem, not the problem about relative location within the visual field itself, which leads Ross and Clark to hold that a subjectivist treatment of location in the visual field is unacceptable. Before turning to that question in Section 4, I want briefly to formulate a theory that will be more satisfactory than either Hardin's subjectivism or Ross's physicalism.

3. The Double-Property Theory

Color subjectivism holds that color properties are exclusively mental properties of our sensations and color physicalism that they are exclusively properties of visible

physical objects and processes. Ross and Hardin both assume that these are the only available alternatives. So Hardin's appeal to metamerism is meant to support subjectivism by undermining physicalism, whereas Ross seeks to uphold a version of physicalism by arguing against subjectivism, both assuming that the two views exhaust the field.

But a third alternative is available. It could be that there are two families of color properties, one a family of mental qualities of visual sensations and the other a family of visible properties of physical objects and processes. Color subjectivism and color physicalism, on this third alternative, are both partly correct, since color properties of both kinds exist. The mistake subjectivism and physicalism both make is to assume that colors are exclusively of one kind, either mental or physical but not both.

One reason this third view is often overlooked is that there seems to be no satisfactory way to specify how each mental color quality corresponds to some particular physical color property. The mental colors would have to be very different kinds of property from the physical colors, since mental colors would be properties of mental states and physical colors properties of physical objects. Physical colors are properties of objects, whereas mental colors are properties of visual sensations, which are not objects but states. So the mental colors will not resemble the physical colors in any informative way; the mental red of visual sensations, for example, in no way resembles the physical red of physical objects. Such resemblance cannot therefore help specify how each mental color corresponds to some particular physical color. And, without some such correspondence, it is theoretically unhelpful to countenance both mental and physical colors.

But we need not seek such correspondence property by property; rather we can find it at the level of whole families of properties. Each mental color corresponds to some particular physical color property not directly, but by way of the place the two properties have in their respective families of color properties. More specifically, the similarities and differences each mental color has to all other mental colors are homomorphic to the similarities and differences that the corresponding physical color property has to all the other physical color properties. Just as mental red, for example, resembles mental orange more than it does mental blue, so physical red resembles physical orange more than physical blue. And similarly throughout the two color spaces.

The relevant similarities and differences here are those describable in terms of our ordinary, commonsense taxonomy of the colors we take physical objects to have, not those describable in terms of wavelengths. The characteristic wavelength profile of physical red, for example, does not resemble that of physical purple more than the wavelength profile physical green. But that resemblance relation does hold among the three physical colors taxonomized in our prescientific, commonsense way. Once again, it is important to understand physical color in the first instance as a commonsense, macroscopic physical property.

This double-property theory, which I have defended elsewhere (Rosenthal 1991, 1998, 1999, unpublished), fits well with our commonsense ways of talking about color properties. We describe physical objects as being colored whether or not they are sensed, and we describe visual sensations as being red, green, and so forth even when the sensations occur in the absence of physical objects of the relevant color.

We use color words both for properties of physical objects and for properties of visual sensations.

It is sometimes argued that, when we describe visual sensations as being red or green, for example, we are really describing those sensations not in terms of their own qualitative properties but in terms of the properties of visible objects (Harman, 1990). Two questions here must be distinguished. A sensation is red if it resembles and differs from other visual sensations in ways homomorphic to the ways red physical objects resemble and differ from physical objects of other colors. So describing a visual sensation as red does indeed make tacit appeal to the visible properties of objects possible. But the sensation itself has a property in virtue of which it resembles and differs from other visual sensations in this way. We pick out the mental qualities of sensations by reference to the perceptible properties of physical objects, but sensations do, nonetheless, have those mental qualities.

This double-property theory applies not only to colors, but also to spatial properties. Physical objects exhibit spatial properties, such as location, size, and shape. But we also describe visual sensations in terms of these spatial properties; indeed, the boundaries of mental color qualities define mental properties of size, shape, and location. And the size and shape that mental color properties determine cannot be the spatial properties that characterize physical objects, since those mental colors are not themselves properties of physical objects. The boundaries between mental color qualities must accordingly determine mental qualities of size and shape.

These mental qualities of size, shape, and location do not correspond one by one to the corresponding spatial properties of physical objects. Instead, the correspondence between them relies on the place each property has in its family of properties. The mental shape of being square, for example, resembles and differs from other mental shapes in ways homomorphic to the ways the physical property of being square resembles and differs from other physical shapes; similarly for other mental shapes and for mental sizes. Just as mental squareness, for example, is more similar to mental rectangularity than to mental circularity, so too for the corresponding properties of physical objects. The same holds for the properties of visual sensations that pertain to location; the mental relations of being to the left of and being to the right of are opposites, as are the mental relations of being above and below.

Ross argues that the failure of color subjectivism shows that some version of color physicalism must be true, whereas Hardin maintains that the failure of color physicalism sustains color subjectivism. The foregoing sections seek to undermine both negative arguments. Section 1 argued that metamerism does not show that colors cannot be physical properties, and Section 2 sought to undermine Ross's contention that treating colors as mental qualities runs afoul of the problem about sensed location. That leaves open both possibilities, that colors are physical properties and that they are mental. The double-property theory goes a step farther, arguing that colors occur as both kinds of property.

4. The Location Problem

Perceiving goes beyond sensing in several ways. For one thing, it involves conceptual content, which sensing does not. But, in addition, perceiving requires some coor-

dination of sensory representations with the things they are supposed to represent. In the case of locations in the visual field, this means that each such location in the field must be coordinated with some physical location that the field location represents. More explicitly, for any location in the visual field, a sensation at that location must be coordinated with an object at some physical location that the sensation represents for the purposes of perception.

It is likely, as noted earlier, that this problem leads Ross and Clark to reject a subjectivist account of location in the visual field. Accordingly, Ross argues that we must identify positions in the visual field by way of relations the perceiver bears to the physical locations perceived physical objects occupy. But we can identify locations in the visual field independently of any coordination of those locations with the physical locations they represent. We can impose on the visual field a spatial structure by way of mental qualities pertaining to space, and thus individuate positions in that field.

But perceiving requires the additional step of coordinating positions in the visual field with the physical locations we sense. Simply imposing a spatial structure on the visual field is not enough to coordinate mental with physical locations. Nor does the double-property theory, by itself, help. That theory addresses only the question of how the various *types* of mental quality correspond to the various *types* of physical property, and coordinating individual positions in the visual field with individual physical locations is a question not about types but about individual locations. Nor is there any mystery on the double-property theory about instances of the mental qualities; they are just instances of the relevant types.

Types of property are *repeatable* in that distinct instances of the property can occur at different times and places. And Ross, again following Clark, argues that repeatable mental-quality types pertaining to spatial relations cannot spatially define the visual field. But instances of these mental-quality types can; it is precisely instances of spatial mental qualities that define each particular instance of the visual field.

Mental red is that property which resembles and differs from other mental color qualities in ways homomorphic to the ways physical red resembles and differs from other physical color properties. Similarly, mental triangularity is that mental quality that resembles and differs from other mental shape qualities in ways homomorphic to the ways physical, geometric triangularity resembles and differs from other properties of physical shape. But these correlations cannot establish ties between individual occurrences of mental qualities, whether color qualities or spatial qualities, and the individual physical objects we sense and the physical locations those objects occupy.

Ross and Clark assume that this coordination can be done relying only on resources proper to the visual modality. And since no theory shows how to do that, they conclude that we must simply identify positions in the visual field by way of relations the perceiver bears to the physical locations occupied by perceived physical objects. But we should be cautious about accepting this conclusion, since we can identify positions in the visual field independently of such relations.

And there is a way out. It may well be that the coordination of individual positions in the visual field with particular physical locations relies not just on considerations proper to the visual modality, but to connections vision has with other sensory modalities. Rather, it is likely that some calibration of visual information with sensations from other modalities is needed. For individual locations in the visual field to corre-

spond to physical locations, we very likely must coordinate positions in the visual field with those in the sensory fields of touch and of proprioception, since proprioception pertains to motor function. Which mental qualities in the visual field correspond with which physical objects and locations is a function of how positions in the visual field correspond to those in the tactile field, as well as what happens in those sensory fields when we reach for, grasp, and move things and run into things when we ourselves move.

Positions in the visual field appear to correspond directly with physical objects at various locations because these cross-modal calibrations and perceptual–motor coordination are so thoroughly second nature to us that we take them as given. But occasional disparities, as when we put on glasses that distort in ways we are unused to, remind us that these cross-modal and perceptual–motor calibrations are indeed learned. And these disparities allow us to experience subjectively how the seemingly natural correspondence between physical locations and positions in the visual field can break down. And, since we cannot require the double-property theory to explain this correspondence between individual mental and physical locations, that view does, after all, provide a defensible theory of the nature of both color properties and the associated mental properties pertaining to spatial matters.

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