

Color: A Functionalist Proposal

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Colour is the most sacred element of all visible things.

John Ruskin, Modern Painters III, IV, xiv, §42

Color provides a focused domain within which to pursue general questions (emphasized, for example, in [Sellars(1963)Sellars]) about whether and how we can reconcile the description of the world given to us by our ordinary perceptual experience, on the one hand, and the description of the world given to us by scientific and philosophical inquiry, on the other. In this paper I attempt to carry out this pursuit by offering a proposal about the nature of color that I call *color functionalism*. I shall lay out and explain the view I want to defend (§1), assess that view in terms of the contrast between primary and secondary qualities (§2), and then contrast color functionalism against other, more traditional, views about color (§3). I'll conclude that color functionalism is a plausible alternative to traditional proposals about the nature of color.

1 Color Functionalism

We may begin our search for a theory of color with this platitude: certain objects look colored to us.¹ Of course, they look colored to us only under certain circumstances — for instance, when we are looking at them and they are illuminated. To be more precise, then, we might say that certain objects are *disposed* to look colored to us. For example, the ripe lemon before me now has such a disposition: when I attend to the lemon (under the conditions I am now in), the lemon looks yellow to me — it produces in me, under these conditions, the characteristic kind of visual experience of looking yellow. More generally, it seems hard to deny that color properties (if they exist) occasion particular visual experiences in certain kinds of organisms under appropriate circumstances, and that things that have color properties are disposed to occasion particular visual experiences in certain kinds of organisms under appropriate circumstances.

On the basis of these considerations, I want to propose a view about the nature of color. This view, which I call *color functionalism*, has it that colors are the properties

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¹Here and throughout the present work I intend a phenomenal reading of 'looks' locutions (cf. [Jackson(1977)Jackson], chapter 2 on the different uses of 'looks').

that dispose their bearers to look colored.² For example, on this view, *red* is the property that disposes its bearers to look red, and *green* is the property that disposes its bearers to look green.³ *Mutatis mutandis* for the other colors.

1.1 Color Functionalism as a Functional Analysis

Color functionalism understands colors as being constituted in terms of their functional roles. Thus, according to functionalism, *red* is the property that it is in virtue of its filling a particular functional role — viz., that of disposing its bearers to look red. Because it analyzes colors in terms of their functional roles, color functionalism is (as its name suggests) a functional analysis. This point has several significant consequences.

First, like any functional analysis, color functionalism understands the properties it analyzes in a way that is independent of their structural or material constitution: what determines whether something has the property *red* is not whether it has some particular structural or material constitution, but whether it fills the relevant functional role. In this sense, functionalism can be thought of as quantifying over first-order structural configuration types: *red* is the property of having some or other structural configuration type that confers upon its bearers the disposition to look red.⁴

A reflex of this point is that, on color functionalism, a color such as *red* will be realized by different structures in different possible worlds: a structure that disposes x to look red in world w_1 may not dispose x to look red in world w_2 , depending on the degree of similarity between the physics (and psychology) of w_1 and w_2 . By way of comparison, note that if (as is plausible) the property *being a can-opener* receives a functional analysis, it may be that a given structure counts as an instance of this property in w_1 and fails to count as an instance of this property in w_2 ; this will happen if the physics of w_1 and that of w_2 are sufficiently unlike that what fills the functional role of opening cans in w_1 turns out not to fill the functional role of opening cans in w_2 . Moreover, and for the same reasons, color functionalism leaves it open that there may be many distinct structures that count as realizers of *red* within world w ; this will happen if the different structures all fill the functional role of disposing their bearers to look red in w . And again, this is just what we expect from a functionally analyzed property: if *being a can-opener* is analyzed functionally, we expect that property to apply to many different structural and material configurations (can openers made of steel, can openers made of gold, mile-long can openers, newly conceived structures that you invent in your basement one afternoon) within a world w just so long as all

²This is not an entirely novel view: related accounts are defended in [Jackson and Pargetter(1987)Jackson and Pargetter], [Jackson(1996)Jackson], [Jackson(1998b)Jackson], and [McLaughlin(2003)McLaughlin]. I have also defended color functionalism at greater length in [Cohen(2000)Cohen]. My version of color functionalism differs from those cited mainly in that (i) I have attempted to bring out the functionalist character of the view and the consequences of this character more centrally than others, and (ii) I disagree with these authors about how to motivate the view. The label ‘color functionalism’ is my own.

³As I shall discuss below, the property that disposes its bearers to look red (the property that disposes its bearers to look green, etc.) may turn out to be realized disjunctively in some (actual or non-actual) world. For this reason, the uniqueness presuppositions carried by the definite descriptions I have used to characterize the colors are not in conflict with empirical results about the physical heterogeneity of red things (or green things, etc.).

⁴Although functionalism makes colors second-order properties in this sense, it makes colors first-order in the distinct sense that they are exemplified by concrete particulars rather than types.

of them fill the functional role of opening cans in w .

A further, and related, feature of color functionalism is that the view is officially neutral on whether colors are disjunctive properties in world w , whether colors are physical properties in world w , and so on. If it should turn out that, in world w , the property that disposes things to look red is a non-disjunctive or a non-physical property, then functionalism will hold that the property *red* is, in w , a non-disjunctive or a non-physical property. Current scientific evidence suggests strongly that the properties that dispose things to look colored in the actual world are physical and disjunctive, hence (on functionalism) that colors are physical and disjunctive in the actual world (see [Nassau(1980)Nassau]). But this fact (if it is a fact) is not required by functionalism. I take it that the neutrality of functionalism on such questions is a virtue, since it allows for a possibility that is actual — namely, that we denizens of the actual world can talk about colors in worlds very different from our own if we so choose.

Notice, however, that if it is true (as it seems to be) that red things can have any of a number of physically quite disparate structural makeups, then this gives us reason for preferring a view on which colors are not tied to particular structures. For in this case we should prefer an account that vindicates the claim that these physically disparate structures all share one and the same color (more on this in §3.3). As noted already, color functionalism allows for this outcome. Moreover, color functionalism, unlike many views about color (see, for example, those of [Hilbert(1987)Hilbert] and [Lewis(1997)Lewis]), needn't restrict itself to surface color, but applies straightforwardly to the colors of luminous sources, volumes, and so on; for, so long as a luminous source or a volume has the property that disposes its bearers to look colored, color functionalism will count that luminous source or volume as an instance of a color. Color functionalism even makes sense of the (pre-theoretically plausible) claim that a surface and a volume can share one and the same color: for example, the surface of a banana and a volume of beer share the same yellow color just in case they both have the property that disposes its bearers to look yellow. In this sense, color functionalism permits a completely unified treatment of surface color, volume color, source color, aperture color, and film color — it explains why they are all species of *color*.

Is color functionalism the view that colors are the bases for the dispositions to look colored?⁵ Not if we think that a basis is only contingently connected with the disposition for which it is a basis. For, on functionalism, the colors are essentially — constitutively — connected with the dispositions to look colored. According to color functionalism, the bases for the dispositions to look colored are not *identical* with the colors, but are *realizers* of the colors (in particular possible worlds). For example, suppose physical configuration P is a basis for the disposition to look red in the actual world. For the functionalist, *red* is (not P but) that functional property that disposes its bearers to look red, and this functional property happens to be realized, in the actual world, by P . But since the property that disposes its bearers to look red fails to be realized by (indeed, fails to coincide with) P in other possible worlds, the former cannot be identified with the latter.⁶ Analogously, if the description 'the inventor of bifocals' applies to whatever individual invented bifocals, and if it so happens that Benjamin Franklin satisfies that description in the actual world, it does not follow

⁵See [McLaughlin(1995)McLaughlin] for more on the metaphysics of dispositions, bases, and related notions.

⁶Here I follow [Kripke(1980)Kripke] in holding that *de re* statements of property identity must be necessary if true; if so, the non-coincidence of *red* and P in *any* world shows that the two are not identical.

that ‘the inventor of bifocals’ picks out Benjamin Franklin in every world, or that that description is synonymous with ‘Benjamin Franklin’. Rather, ‘the inventor of bifocals’ expresses a descriptive content that happens to be satisfied, in the actual world, by Benjamin Franklin.

Finally, color functionalism provides a clear explanation of the relation between the philosophical project of attempting to specify the nature of colors, on the one hand, and the scientific project that goes by the same description, on the other. Namely, if we follow functionalism in understanding the colors in terms of certain functional roles, we can understand the scientific project of attempting to specify the nature of colors as the empirical project that attempts to determine the physical (or non-physical) structures that happen to fill those functional roles in the actual world.^{7 8}

1.2 Functionalism and Perceptual Variation

Any theory of color must face a set of empirically motivated concerns about inter-subjective and intra-subjective variations in color perception.⁹ Psychophysicists have devoted considerable energy to showing that things look differently in respect of color to distinct subjects in identical viewing conditions, and to a single subject in distinct viewing conditions. For example, even restricting ourselves to normal human beings with three working types of cones with typical wavelength-sensitivity curves, there are interpersonal differences in the absolute and relative populations of each receptor-type in the retina,¹⁰ in the filtering yellow pigment of the macula and the lens of the eye ([Hurvich(1981)Hurvich], 113–116) and in cone absorption spectra ([Boynton(1979)Boynton], 384). As noted by ([Clark(1993)Clark], 164–170) and ([Hurvich(1981)Hurvich], 222–223), these sources of variation result in a non-trivial distribution of the loci for unique green between 490 and 520nm even among non-anomalous trichromats.¹¹ In addition to these sources of interpersonal perceptual variation, there are many intrapersonal differences of color vision. Thus, as is

⁷Understanding this relationship between the two projects will provide us with one way of answering the Sellarsian question (mentioned in the first paragraph of the present paper) about the relation between the description of the world given by our experience and that given by science.

⁸The scientific project in question has sometimes been called *color physics*. This terminology will seem somewhat inapt in worlds where non-physical structures fill the relevant functional roles, for in these worlds it will be part of the job of color physics to tell us about certain non-physical structures. Perhaps, then, the relevant science would be better described without use of the term ‘physics’. On the other hand, current evidence suggests that the relevant functional roles are, in the actual world, filled by physical properties, so this (merely terminological) worry appears to have only academic significance in any case.

⁹The themes discussed in this section are explored in greater detail in [Cohen(2004)Cohen].

¹⁰These results have been confirmed by several lines of converging research, including psychophysical methods [Rushton and Baker(1964)Rushton and Baker], [Pokorny *et al.*(1991)Pokorny, Smith, and Wesner], [Cicerone and Nerger(1989)Cicerone and Nerger], [Vimal *et al.*(1989)Vimal, Pokorny, Smith, and Shevell], spectral electro-retinograms [Jacobs and Neitz(1993)Jacobs and Neitz], [Jacobs and Deegan(1997)Jacobs and Deegan], microspectrophotometry [Bowmaker and Dartnall(1980)Bowmaker and Dartnall], [Dartnall *et al.*(1983)Dartnall, Bowmaker, and Mollon], messenger RNA analysis [Yamaguchi *et al.*(1998)Yamaguchi, Motulsky, and Deeb], [Hagstrom *et al.*(1998)Hagstrom, Neitz, and Neitz], and retinal densitometry [Roorda and Williams(1999)Roorda and Williams].

¹¹Unique green is defined as that green hue that appears “perceptually unmixed” — neither bluish nor yellowish in appearance; the locus of unique green for a given observer is the spectral frequency at which monochromatic light appears unique green to that observer. There is a

well-known to anyone who has ever put on or removed tinted sunglasses, adjusted the lighting in a room, or been surprised by changes in the appearance of garments once removed from the flattering viewing conditions of the store, the color a thing looks to a single individual depends on all sorts of parameters of the viewing circumstance including ambient illumination, viewing angle and distance, other objects seen simultaneously, other objects seen previously, state of adaptation of the visual system, and so on.

Such cases of perceptual variation may appear to be a problem for color functionalism, on which *red* is the property that disposes its bearers to look red. For the data about perceptual variation show that x can look red to subject S_1 in circumstance C_1 and fail to look red to subject S_2 in circumstance C_2 . In this scenario, should we say that x has the property that disposes it to look red? Should we answer affirmatively, on the grounds that x looks red to S_1 in C_1 , or negatively, on the grounds that x does not look red to S_2 in C_2 ? And how might we go about choosing between which of these conflicting pieces of evidence is grounds for an answer to the question about the true color that x has?¹²

The approach to these questions I favor involves taking color properties to be relativized to subjects and viewing circumstances. Thus, we may say that *red for S in C* is that property that disposes its bearers to look red to S in C .¹³ On this account, we are not forced to choose between saying that a lump of coal is grey (because it looks grey to Jack when placed next to a surface of lesser lightness) or that it is black (because it looks black to Jill when placed next to a surface of greater lightness). Rather, we admit that the coal is both grey to Jack in C_1 and black to Jill in C_2 . Thus, relativization saves us from having to decide hard cases. This, I take it, is a virtue — hard cases make bad law.

On the other hand, there are two reasons for not remaining content with the relativized version of color functionalism I have proposed. First, our apparently unrelativized uses of color predicates in ordinary (and most scientific) discourse about color suggests that there is an unrelativized form of color properties lurking somewhere. And second, it can often seem counterintuitive to extend the notion of color to cover all the kinds of cases where things look colored to any visual system, and under any viewing circumstance: it can seem odd or inappropriate to say that how things look to dichromats reveals colors that those things have, or that a ripe raspberry is grey in situations of extremely low illumination, although it will certainly look grey (and not red) in such viewing conditions.

The way to reconcile these intuitions with the claim that color properties are relativized, I suggest, is to recognize that ordinary color discourse depends tacitly

similarly non-trivial distribution for loci of the other chromatic unique hues (red, yellow, and blue) as well, although the standard deviation of the distribution is largest for unique green.

¹²These problems can be raised for a number of other views of color as well, including especially other views (such as color dispositionalism — see §3.1) that analyze *red* in terms of *looks red*.

¹³While the strategy of relativization I am recommending on behalf of functionalism seems to me the best way in which a functionalist can respond to the worries about perceptual variation we are considering, this strategy is separable from the core functionalist position. The general strategy of relativizing color ascriptions is available to those who hold positions other than functionalism (such as dispositionalists; see [McGinn(1983)McGinn]), and therefore adopting this strategy is not sufficient for being a functionalist about color. Moreover, the strategy is not strictly necessary for a functionalist, since it is (at least in principle) open to the functionalist to respond to the worries about perceptual variation by an alternative strategy.

on conventionally presupposed ways of filling out the relativizations. In particular, the predicate ‘red’ in our mouths denotes the property that disposes its bearers to look red to visual systems similar to our own and in circumstances like those we typically encounter. How does this reconcile our intuitions with the claim that color properties are relativized? On the one hand, I am claiming that color properties are in fact relativized; this gives us a way of accommodating perceptual variations such as those between the way the lump of coal looks to Jack in C_1 and the way it looks to Jill in C_2 without requiring us to choose between the variants. On the other hand, since the parameters to which color properties are relative are tacitly filled in (in a way that remains relatively stable from occasion to occasion) by the conversational presuppositions in force in ordinary thought and talk about color, they remain inexplicit, and therefore easily overlooked; and this explains our intuitions that color properties are not relativized to perceivers and viewing circumstances. Conflict dissolved.

It may be helpful to compare the present strategy against others that have appeared in the literature. Many writers have attempted to accommodate the kinds of perceptual variation we have examined by claiming that our color ascriptions are tacitly relativized to some sort of standard perceiver and standard circumstances. Thus, for example, some have proposed that *red* is the disposition to look red to the standard perceiver in standard viewing circumstances (cf. ([Peacocke(1984)Peacocke], 60), ([Wright(1992)Wright], 136–137), and [Harman(1996)Harman]). The thought is that although x can look red to S_1 in C_1 and fail to look red to S_2 in C_2 , we can decide whether x is red or not by deferring to the way x looks to a standard perceiver in standard viewing circumstances. However, this standard strategy has come under attack from several authors, including, notably, [Hardin(1988)Hardin], who have argued that there is no non-arbitrary, objective, metaphysically well-motivated way in which to single out a standard perceiver and a standard viewing circumstance.¹⁴ Hence, these critics allege, theories of color that relativize color properties to a standard perceiver and a standard viewing circumstance cannot provide an understanding of the color properties that makes them non-arbitrary, objective, and metaphysically well-motivated.

The present proposal is designed to avoid this problem. For, insofar as this proposal adverts to a standard perceiver and standard viewing circumstances, it does so by means of conversational presuppositions that are in force in our ordinary thought

¹⁴To see the sense of objectivity at issue, consider the property *square*. Of course, it is true that x can look square to observer S_1 in circumstance C_1 and fail to look square to observer S_2 in circumstance C_2 (perhaps S_2 in C_2 is viewing x at an angle oblique to its face). However, we have objective, observer-independent, well-motivated criteria for deciding whether x is square (viz., it is square just in case it is a closed plane figure with four right interior angles and sides of equal length), and this justifies us in selecting a standard observer and standard viewing circumstances for the property *square*. We can say, in this case, that an observer S is a standard observer and a viewing condition C is a standard viewing condition for *square* just in case, by S 's viewing x in C , S can determine whether x meets the (independently certified — in this case, geometrically certified) conditions that are necessary and sufficient for x 's exemplifying the property *square*. We know that S_2 in C_2 is not standard for *square* in this sense, so we are justified in ruling that the way x looks to S_2 in C_2 is irrelevant to the question whether x is an instance of *square*.

In contrast, runs the present objection, we lack a looks-independent characterization for *red* of the sort we have for *square*, so we have no principled way to choose whether a particular observer or viewing circumstance is standard for *red*. Any such stipulation of a standard observer and viewing circumstance for *red*, then, will be arbitrary.

and talk. These presuppositions, which I claim tacitly attend ordinary ascriptions of color properties, can provide notions of the standard perceiver and standard viewing circumstances that will serve ordinary needs, despite being arbitrary (viz., stipulative, conventional). On the other hand, if objective color properties are needed for more recondite scientific or philosophical purposes, we may revert to the (wholly objective) relativized color properties (e.g., *red for S in C*).

A further consequence of the present proposal is that, because it involves tacit presupposed relativization to our own kind of visual system and viewing conditions, we can pay our due to the anthropocentrism inherent in our thought and talk about color. At the same time, since, on the present account, these tacitly anthropocentric elements of our thought and talk about color are cancellable presuppositions rather than essential features of the colors, we needn't give in to an all out species-chauvinism that would make color vision in other organisms metaphysically impossible.¹⁵ This allows us to agree with Hilbert that “discussions of color ontology, as well as a large part of color science, are, after all, primarily concerned with a property that human beings perceive, reflect on, and talk about. If it turns out that this property is not perceived by some other kinds of organisms that is neither surprising nor a challenge to the adequacy of our accounts of this property of particularly human interest” ([Hilbert(1992a)Hilbert], 39; cf. [Hilbert(1992b)Hilbert]). The way to gloss this quotation, given what we've said about the tacit relativization to our own kinds of visual systems and viewing conditions, is that the tacitly relativized properties we ordinarily talk about are indeed of only parochial interest. However, because we are perfectly capable of dropping the tacit parameters, choosing instead to relativize to the way things look to other visual systems and viewing conditions when it suits us, we are capable of talking about colors and color vision more expansively when this is appropriate.

Finally, the current proposal allows us to say both what's right and what's wrong in treating certain perceptual cases as errors of color vision. Suppose x looks red to S in C . In one sense, there's no room for error here: if x does indeed look red to S in C , then there are no grounds for attributing error to S 's color vision — for saying that x is not red to S in C . However, if S or C lie outside the conditions for normality presupposed by our ordinary thought and talk about color, then we can recognize a sense in which the way x looks to S in C can be erroneous; viz., that it does not match the way x looks to S' in C' , where S' and C' are the sorts of perceivers and viewing conditions we take to be normal, and to which we tacitly relativize in ordinary settings. And indeed, this description appears to characterize exactly the kinds of cases we would pre-theoretically call color illusions or errors of color vision. In such cases, the perceiver or viewing conditions (typically the latter) are deliberately manipulated so that they depart from normality, and this leads perceivers to the (completely understandable, but in such cases erroneous) belief that if x looks red to them in such conditions, then x is red (viz., red for normal perceivers in normal conditions). There is no error in reporting, of such a case, that x is red for S in C ; there is an error in reporting, of such a case, that x is red (viz., red for normal perceivers in normal conditions). More

¹⁵In this connection, [Matthen(1999)Matthen] complains that many leading accounts of the nature of color (including, notably, that of [Hilbert(1987)Hilbert]) are unacceptably species-chauvinistic — that their understanding of color properties primarily in terms of the effects of these properties on beings of our own species results in an inappropriately limited theory. The account I am recommending evades this worry because, although it gives a special place to our species-chauvinistic presuppositions in fixing ordinary uses of color terms, it allows us to talk about the color properties perceived by other kinds of organisms in a perfectly straightforward sense.

generally, when x looks red to S in C , S is correct in judging that x is red for S in C , but may err in judging that x is red for S' in C' .¹⁶

In sum, it seems to me that color functionalism provides a plausible treatment of the problems concerning perceptual variation surveyed in this section while respecting a wide range of intuitions to which a theory of color ought to be responsive.

1.3 Functionalism and Color Experience

Color functionalism holds that *red* is the property that disposes its bearers to look red (and likewise for the other colors).¹⁷ The view gives us an account of the property *red* in terms of the property *looks red*. However, this leaves us with the question what it means to say that something looks red. The obvious worry that arises at this point is whether we won't be forced to analyze *looks red* in a way that depends upon a prior understanding of *red*, thereby initiating a regress.¹⁸ The response I favor will be to say that there is in fact a regress, but that it is not a vicious one, and that it does not undermine my proposal.¹⁹

To start, then, let me lay out the connection between color properties and color experience, as I conceive it. The first step is the (by-now familiar) functionalist analysis of *red*:

(A1) *red* is the property that disposes its bearers to look red.

Of course, (A1) unpacks *red* by appeal to *looks red*, and thereby invites the question what it is for something to look red. I propose that x looks red just in case x causes experiences of red. Or, in full dress,

(A2) x looks red to S in C just in case, by visually attending to x in C , S is appro-

¹⁶This sort of error is important because colors are frequently used to support inductions about non-color properties, and for purposes of object-reidentification. For example, when a mango looks green to S in C , S will typically conclude that the mango is unripe (presupposing relevant facts about the perceiver S and the perceptual circumstance C). Or again, when x_1 looks red to S in C_1 at time t_1 and then x_2 looks red to S in C_2 at time t_2 , S may use this information to infer that $x_1 = x_2$, presupposing (correctly or incorrectly) that C_1 and C_2 are relevantly similar. (I owe this point to Mohan Matthen.)

¹⁷Here and in what follows I shall usually omit, for ease of expression, the tacit relativizations I have claimed (§1.2) figure in our thought and talk about colors.

¹⁸The regress at issue is brought out explicitly in [Boghossian and Velleman(1989)Boghossian and Velleman], and is also discussed in [Sellars(1956)Sellars].

¹⁹I want to emphasize that the problem we are now considering is not a problem with color functionalism itself; it is not, for example, the accusation that that view is internally inconsistent. It is, rather, the concern that the combination of color functionalism together with other (plausible) views about color experience has undesirable features. Consequently, one avenue of response to the circularity problem that is open to a proponent of functionalism is to insist on functionalism but to reject those views about color experience which, when combined with functionalism, result in circularity. E.g., we might follow [Peacocke(1984)Peacocke] in holding that, while *red* is to be understood in terms of *looks red*, the latter does not contain 'red' as a semantically significant constituent (despite the appearance that it does). Unfortunately, I find the analysis of *looks red* in terms of *red* attractive, and am not willing to sacrifice this analysis in order to save functionalism. Therefore, I need another response to the accusation of circularity.

priately caused (in C) to have an experience of red.^{20 21}

The final step explains *experience of red* in terms of *red*:

(A3) *experience of red* is a type of mental state of subjects that is the typical effect of attending to red things.

We are now in a position to examine the worries concerning the circularity of the proposal now before us. In this connection, I want to distinguish two separate questions. The first question is semantic, and stems from the worry that the interdependence of the elements of the proposed explanation of the connection between color properties and color experience makes that explanation uninformative. The second, metaphysical, question is whether and how the explanation provides an adequate understanding of the metaphysics of color experience. I'll take these questions in turn.

The semantic worry about the uninformativeness of (A1)–(A3) is that, since (A1) analyzes *red* in terms of *looks red*, (A2) unpacks *looks red* in terms of *experience of red*, and (A3) understands *experience of red* in terms of *red*, the proposal as a whole “is not flatly circular, but something like it. It has the form, figuratively speaking, of a closed curve in space” ([Quine(1953)Quine], 30). That is, because each step in the chain presupposes understanding of one of the other notions explained elsewhere in the chain, the chain won't be informative to someone who lacks any way of entering into it — someone who can identify neither red things, nor things that look red, nor experiences of red.

I am prepared to admit that my explanation of the relation between color properties and color experience is uninformative in this sense; however, I deny that this fact undermines it or any of its elements.

For one thing, even if the explanation is uninformative to one who can identify neither red things, nor things that look red, nor experiences of red, this is not a problem for you or me, since you and I *can* (I trust) identify red things, things that

²⁰I shall not attempt to unpack the notion of visual attention appealed to here, except to say that I take it to be a psychological mechanism that picks out certain objects represented in the visual field. Pylyshyn has developed a view of visual attention to which I'm sympathetic; see [Pylyshyn(1989)Pylyshyn], [Pylyshyn(1994)Pylyshyn], and the references therein.

I shall also refrain from saying anything substantive about the notion of appropriate causation, except that I appeal to it in order to exclude so-called deviant or wayward causal chains (cf. ([Davidson(1973)Davidson], 78ff), [Peacocke(1979)Peacocke]).

²¹This proposal evades a worry discussed in [Gold(1999)Gold]. Gold worries that statements of the form ‘ x is pale blue just in case x looks pale blue’ results in our seeing too many instances of color properties, since both x and the light coming from x to the visual system can be said to be disposed to look pale blue:

If something is colored just in case it has a disposition to look colored, then when we look at a pale blue urn, we are actually seeing an identical disposition in two distinct things, namely, the color of the urn and the color of the light reflected by the urn ([Gold(1999)Gold], 30).

But if we hold, as I propose, that x cannot look pale blue unless *visually attending* to x appropriately causes a visual experience of the right sort, then we can make the necessary distinctions among instances of colors. For although, in this case, we can say that the light is disposed to look pale blue to S in circumstances in which S is visually attending to the light, it will not be true that the light manifests this disposition — that it looks pale blue to S — in circumstances in which S is visually attending to the urn rather than the light. Thus, both the light and the urn may be disposed to look pale blue to S ; but it is false that both look pale blue to us whenever one of them does. And if, plausibly, we can't see the color of an object that doesn't look colored to us, it will be false that we see both instances of the color whenever we see one of them.

look red, and our own experiences of red. Of course, we must not have acquired the abilities to identify these things exclusively by appeal to the explanation I have set out, precisely because, prior to possessing these abilities, we would have found the explanation as a whole uninformative. That is to say that the present objection about the unformativeness of the explanation would indeed be damning if the explanation itself were the only means by which we could have acquired the identificatory abilities we in fact have. But it is plausible that our ability to identify red things is grounded in ostension to local exemplars — that induction from ostensive exposure to red things (aided by cues including utterances of ‘red’, in the context of our desire to coordinate our linguistic and non-linguistic behavior with locally prevailing conventions) enabled us to identify at least one red thing, and that this gave us a way to break into the explanation I have proposed. For, having identified a red thing in this way, we could then appeal to (A3) in order to identify our own experiences of red, and from this point we could use (A2) and (A1) to understand *looks red* and *red* (see [Lewis(1997)Lewis] and [McLaughlin(2003)McLaughlin] for a fuller discussion of this process). Thus, the unformativeness of the chain of analyses will not prevent its use by those who can already identify red things (or things that look red, or experiences of red), and since these abilities can be given to those who lack it, the chain can be used by them too.²² Therefore, the circularity of the chain (A1)–(A3) does not prevent its components from doing the work they are intended to do.

On the contrary, I want to suggest that the unformativeness of the explanation is just what we should expect if functionalism is a correct theory of the nature of color. For, as many writers have argued, our most important way of thinking and talking about our color experiences (perhaps our only way; see [Harman(1990)Harman]) is in terms of the representational content of those experiences. If this is right, then we have no choice but to understand our color experiences partly in terms of the properties they represent as being instantiated — in terms of *red*, *yellow*, and so on. Therefore if functionalism is correct in analyzing *red* in terms of certain experiences, there will be no avoiding an explanation whose parts are mutually interdependent, and hence unformative in the sense under discussion. McGinn puts this point nicely:

In the case of ‘red’ and ‘looks red’ it seems to me that the alleged circularity is just what we should expect, because we are explaining the instantiation of a quality in terms of the production of experiences with a certain intentional content — and such experiences necessarily consist in representing the world as having certain qualities. We might say that the ‘circularity’ arises, not because being red is inherently resistant to

²²Objection: In that case, why accept (A1)? If the ability to pick out red things is not, as a matter of ontogenetic fact, conferred by learning (A1), but by carrying out some inductive procedure from exemplars, why retain (A1) as a correct analysis of *red*?

Response: (A1) is not intended as a lesson for those who do not know how to pick out red things. It is intended as a proposal about the metaphysics of the property to which we selectively respond when we pick out red things — viz., the property *red*. Maintaining (A1) as an account of the metaphysics of *red* is compatible with endorsing the view that we learn to identify instances of that property without knowing (A1). By way of analogy, we may learn to identify water by some of its superficial features (that it is clear, wet, tasteless, potable, comes from the local taps), even though these features do not give us metaphysically necessary and sufficient conditions for being water. After this initial identificatory ability is in place, if we are so inclined, we may come to desire an understanding of what is metaphysically necessary and sufficient for qualifying as an instance of water — the stuff we happen to identify by its merely superficial features; and at this second stage we’ll need to discern something that goes deeper than the superficial features grounding our identificatory abilities.

... analysis [in terms of 'looks red'], but rather because the analysans in inherently intentional: experiences are distinguished by their representational content, so naturally we shall need to use predicates of the external world in specifying them ([McGinn(1983)McGinn], 7).

For these reasons, then, I do not believe that the semantic question about uninformative-ness exposes any fatal problem in the views I am maintaining.

Apart from this semantic question, however, (A1)–(A3) leaves open important metaphysical questions about color experience. Namely, even granting the truth of the proposed explanation of the connection between color experience and color properties, we may wonder whether this gives us a sufficiently complete analysis of color experience: even if, as per (A3), *experience of red* is a type of mental state of subjects that is the typical effect of attending to red things, it may be that there is more to be said about the metaphysics of the mental state type in question. We may, for example, wonder whether the type in question is constituted by its members' having a common functional or representational profile [Harman(1990)Harman], [Dretske(1995)Dretske], [Tye(1995)Tye], a common neural realization [Hill(1991)Hill], a common irreducible phenomenological feel [Chalmers(1996)Chalmers], or some other feature.

I have not yet answered this question, and I do not wish to answer it here. For my purpose here is only to defend color functionalism — a theory about the metaphysics of color properties that is (as far as I can see) neutral on the important and controversial question of the metaphysics of color experience. I see the detachability of color functionalism from views about color experience as a benefit of the former, because it means that proponents of many different answers to the latter question can (in principle) accept color functionalism.

2 Functionalism, Primary Qualities, Secondary Qualities

Philosophical debate about color over the last four hundred years has centered largely on a contrast between two technical notions tied closely to the development of modern physics: primary and secondary qualities. Much realist writing on color has taken the central question about color as a choice whether to construe colors as primary or secondary qualities, and has viewed these positions as exhausting the space of options.²³

In my view, this assessment of the space of options leaves the functionalist view

²³Thus, for example, Locke divides the properties of bodies into the mutually exclusive categories of primary and secondary qualities, and frames his discussion of color in ([Locke(1975)Locke], book II, chapter 8) as an argument that color is a secondary quality rather than a primary quality. In a similar spirit (except that they also make room for a third sort of realism on which colors are irreducible) Byrne and Hilbert write that,

Color *realism* . . . comes in three mutually exclusive varieties, which may be taken to exhaust the space of plausible realist theories. According to *dispositionalism*, colors are *psychological* dispositions: dispositions to produce certain kinds of visual experiences. According to both *primitivism* and *physicalism*, colors are not psychological dispositions; they differ in that primitivism says that no reductive analysis of the colors is possible, whereas physicalism says that they are physical properties ([Byrne and Hilbert(1997a)Byrne and Hilbert], 263).

of §1 out, and therefore overlooks a viable alternative.²⁴ That said, there remains the question whether, on the criteria by which these technical terms were introduced into philosophical usage, functionalism should be counted as a primary or secondary quality theory. I believe that all of the historically salient criteria for the distinction that yield a decisive verdict classify functionalism as a primary quality theory; consequently, I shall be arguing that functionalism is a species of primary quality theory, although, to be sure, a non-traditional species.²⁵

I'll begin, then, by reviewing some historically important formulations of the distinction between primary and secondary qualities. Although the distinction was made by several modern philosophers, it will suffice for present purposes to restrict our attention to the distinction as it is formulated by Galileo, Boyle, and Locke.

2.1 Un Peu D'Histoire

2.1.1 Galileo

Galileo presents the distinction principally as a conceptual distinction between those properties that can and those that cannot be separated from matter in imagination. In *The Assayer* he writes,

... whenever I conceive of any material or corporeal substance, I am necessarily constrained to conceive of that substance as bounded and as possessing this or that shape, as large or small in relationship to some other body, as in this or that place during this or that time, as in motion or at rest, as in contact or not in contact with some other body, as being one, many, or few — and by no stretch of imagination can I conceive of any corporeal body apart from these conditions. But I do not at all feel myself compelled to conceive of bodies as necessarily conjoined with such further conditions as being red or white, bitter or sweet, having sound or being mute, or possessing a pleasant or unpleasant fragrance ([Galileo(1989)Galileo], 56).

Galileo goes on, however, to make two further points about the secondary qualities (those that can be separated in thought from matter) that are stressed by later writers

²⁴The same moral is suggested by [Jackson and Pargetter(1987)Jackson and Pargetter], who view their proposal as a primary quality theory of color, but one that captures many attractive features of secondary quality theories.

²⁵I'm emphasizing that 'primary quality' and 'secondary quality' are technical neologisms as a way of forestalling the objection (one that several people have made when I've presented these views) that functionalism is "obviously" or "intuitively" not a primary quality theory.

I think this objection rests on a methodological error. For, although it appears that the modern philosophers who first deployed the distinction had not considered color functionalism (and therefore did not express views about which side of the distinction functionalism falls on), the distinction is between two technical terms; therefore questions about its application to new cases should be decided by appeal to the criteria in terms of which it was developed, not by appeal to intuitions. (Compare: if, in a class in abstract algebra, we gave contrasting definitions of 'field' and 'ring', we would decide on the applicability of these notions to a new mathematical structure by asking whether it satisfied the definitions, not by consulting our intuitions.)

Why, then, do people keep insisting to me that functionalism is obviously not a primary quality theory? I conjecture that this is because they think of primary quality theories exclusively in terms of the best-known, traditional instances, and they realize, quite correctly, that functionalism is not a theory of that form.

as well. He claims that secondary qualities (i) inhere in the minds of observers, and are not really properties of the objects to which they are typically ascribed, and (ii) consequently, would not survive the destruction of all observers:

...were they [secondary qualities] not escorted by our physical senses, perhaps neither reason nor understanding would ever, by themselves, arrive at such notions. I think, therefore, that these tastes, odors, colors, etc., so far as their objective existence is concerned, are nothing but mere names for something which resides exclusively in our sensitive body, so that if the perceiving creature were removed, all of these qualities would be annihilated and abolished from existence ([Galileo(1989)Galileo], 56–57).

2.1.2 Boyle

In contrast to Galileo, Boyle and Locke initially present their versions of the distinction by enumerating the primary qualities of matter. Boyle, who is credited with the terminology of primary and secondary qualities, writes that, “bulk, figure, and either motion or rest... are the three primary and most catholic moods or affections of the insensible parts of matter, considered each of them apart” ([Boyle(1979)Boyle], 51). In addition, Boyle allows that the situation, or position, of corpuscles is a primary property, although he recognizes that this property is (unlike the other three properties he lists) relational. In explaining why this relational property is primary, Boyle endorses one of Galileo’s criteria for the primary qualities — viz., their perceiver-independence: although situation is a relational property, it counts as primary because, while the situation of a given corpuscle depends on the existence of other corpuscles, it is irrelevant whether these other corpuscles include some that make up a perceiver. Boyle goes on to claim that the non-primary qualities of objects are not only perceiver-dependent, but dispositional in character; they are either dispositions to cause perceivers to undergo certain experiences (what Boyle calls sensible properties) or dispositions to cause changes in the sensible properties of other objects. Again, with Galileo, Boyle holds that secondary qualities are not truly properties of the objects to which we attribute them: “there is in the body to which these sensible qualities are attributed nothing of real and physical but the size, shape and motion or rest, of its component particles...” ([Boyle(1979)Boyle], 31). And, like Galileo, Boyle concludes from this that the secondary qualities would disappear if there were no perceivers.

2.1.3 Locke

Locke’s famous list of the primary qualities is very similar to Boyle’s; it includes “solidity, extension, figure, motion or rest, and number” ([Locke(1975)Locke], II, 8, §9). Locke thinks that the primary qualities are inseparable from matter not only in thought (as Galileo claims), but also in fact: primary qualities are “such as are utterly inseparable from the body, in what estate soever it be; and 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...” ([Locke(1975)Locke], II, 8, §9). He thinks the secondary qualities, “are in truth, nothing in the objects themselves, but powers to produce various sensations in us by their primary qualities” ([Locke(1975)Locke], II, 8, §10). Like his predecessors, Locke holds that the dispositional nature of secondary qualities makes them beholden

for their existence on the existence of perceivers: “Take away the sensation of [secondary qualities]; let not the eyes see light or colours, nor the ears hear sounds, let the palate not taste, nor the nose smell; and all colours, tastes, odours, and sounds, as they are such particular ideas, vanish and cease, and are reduced to their causes, i.e., bulk, figure, and motion of parts” ([Locke(1975)Locke], II, 8, §17).

2.2 Functionalism and the Criteria of Primary Qualities

It is beyond the scope of this paper to discern the relations between the different historical formulations of the distinction between primary and secondary qualities in any detail. Instead, I propose to collect an inclusive list of characteristics from the above passages that are taken to distinguish secondary from primary qualities, and then consider whether colors, as construed on the functionalist account of §1, have these characteristics.

The characteristics of secondary qualities I find in the historical sources I have considered are these:²⁶

Perceiver-Based Specification The specification of secondary qualities (but not primary qualities) must advert to perceivers. Thus, ‘body b is square’ is in no way elliptical, while ‘body b is red’ is always a short form for something like ‘body b causes sensations of type r in perceiver S under circumstances C .’

How does color functionalism come out on this characteristic? If colors are the properties that dispose their bearers to look colored, then of course it will be possible to provide a specification of the colors that adverts to perceivers. Namely, the color *red* can be specified by the expression ‘the property that disposes its bearers to look red to perceiver S in circumstance C ’ (*mutatis mutandis* for the other colors). However, according to functionalism, colors may also be specified without adverting to perceivers; namely, it will be possible to describe a color like *red* in terms of the world-indexed, infinite list of mechanisms that fill the role of disposing things to look red to S in C in each world (there will be different mechanisms in different worlds, and these may turn out to be physical or non-physical, disjunctive or non-disjunctive, and so on). Such infinite lists may not be particularly useful for practical purposes, but their availability means that, according to functionalism, colors have specifications that do not advert to perceivers, and hence fail to meet this criterion for being secondary qualities.

Perceiver Dependence The existence of secondary qualities (but not primary qualities) depends crucially on the existence of perceivers. Thus, if there were no perceivers, there would be no secondary qualities.

Again, it seems to me that color functionalism will classify colors as primary qualities, according to this criterion. Of course, if there were no perceivers, then nothing would ever look colored to any perceiver. However, even if there were no perceivers, things would still have the properties that dispose them to look

²⁶The list that follows is meant to be maximally inclusive; I’m not claiming that all of the authors would agree to every one of these criteria, but only that each of the criteria can plausibly be extracted from some one of the formulations we have considered. (In fact, I doubt that all the features on the list are mutually compatible, although I cannot consider this matter in any detail here.) In addition, I’m not insisting that these criteria (or any set of them) are supposed by their proponents to provide anything like a *definition* of secondary qualities; they may instead form something like a set of typical markers of secondary qualities (cf. [McGinn(1983)McGinn], 5).

colored. But according to color functionalism, colors just are the properties that dispose their bearers to look colored. Therefore, even if the existence of perceivers were impossible, things would still have their colors, which is just to say that, according to functionalism, the existence of colors does not depend on the existence of perceivers. Consequently, this criterion classifies colors, as functionalism understands them, as primary rather than secondary qualities.²⁷

Fragility The existence of secondary qualities (but not primary qualities) depends crucially on whether conditions are suitable for perception. Thus, modifying the surrounding conditions (by lowering the level of the ambient lighting, for example) will obliterate the secondary qualities a thing has (and may or may not replace them with a different set of secondary qualities). Primary qualities are not similarly fragile with respect to the surrounding conditions.

It seems that, according to color functionalism, colors fail to satisfy the criterion of fragility as well. Admittedly, changes in the ambient viewing conditions may have the effect of preventing the manifestation of (at least certain of the) dispositions to look colored. But preventing the manifestation of the disposition does nothing to change the properties that confer the disposition, and consequently will leave intact the properties that dispose their bearers to look colored. Consequently, on functionalism, colors are not fragile in the way that secondary qualities are said to be.²⁸

Dispositional Secondary qualities (but not primary qualities) are fundamentally dispositions; they are dispositions to produce experiences (in this case, color experiences) in perceivers.

Colors will fail to satisfy this criterion straightforwardly, on color functionalism. For, on this view, colors are not the dispositions to produce reactions in perceivers, but rather the properties that dispose their bearers to produce these reactions — the properties in virtue of which things have their dispositions to look colored. On color functionalism, then, colors are numerically distinct from the dispositions to look colored. Consequently, if a secondary quality theory of color must identify colors with dispositions to look colored, functionalism is not a secondary quality theory of color.

Inessential Secondary qualities (but not primary qualities) can be separated in imagination from the bodies they are said to qualify. Thus, (assuming colors are

²⁷That said, I think there is a different kind of perceiver-dependence that attaches to both functionalism and traditional secondary quality theories, but not to traditional primary quality theories of color. Namely, functionalism and traditional secondary quality theories construe colors as constituted in terms of relations to perceiving subjects, while traditional primary quality theories do not. This seems to be one legitimate sense in which accounts of the first two sorts do (while accounts of the third sort do not) count as “subjectivist” theories of the nature of color (cf. [Stroud(2000)Stroud], 124ff). As noted in the main text, this point does not require the actual existence of perceivers in order for colors to exist: all that is required is that things are related to perceivers in such a way that they *would* (perhaps counterfactually) produce characteristic reactions in perceiving subjects.

²⁸Indeed, it seems to me that even dispositionalism should count as a primary quality theory of color according to the criterion of fragility. For prevention of the manifestation of a disposition is not equivalent to destroying the disposition: if x has the disposition to φ in activation conditions ξ , and we ensure that x is not in conditions ξ , then it remains true that x has its disposition to φ in activation conditions ξ , even though (because x is not in conditions ξ) it is not currently manifesting that disposition. Cf. [McDowell(1985)McDowell], [Johnston(1992)Johnston].

secondary qualities and shapes are not) we can imagine a body that is literally without color, but we cannot imagine a body that is literally without shape. Likewise, bodies can survive the destruction of their secondary (but not their primary) qualities.

Once again, color functionalism would prevent colors from satisfying this criterion for being a secondary quality.²⁹ For, according to functionalism, a body is red just in case it has the property that disposes its bearers to look red. This property, as noted in §1.1, will be realized in a particular instance by some material configuration or other (physical or non-physical). Thus, to imagine a red body ceasing to be red is to imagine that body as first having, and then lacking, some material configuration that is the basis for its disposition to look colored. Of course, the body cannot first have and then lack this material configuration without undergoing a change in its material (physical or non-physical) constitution. But, as Galileo, Boyle, and Locke would have agreed, the material constitution of a body is essential to that body. Consequently, a body cannot lose its color without compromising its identity.³⁰ I conclude, then, that functionalism classifies colors as primary qualities according to the criterion of Inessentiality.

Unreality Secondary qualities do not (but primary qualities do) in fact inhere in the objects to which we attribute them. Rather, we project secondary qualities onto objects on the basis of what happens in our own consciousness; significantly, such projections are *erroneous* attributions.³¹

Again, colors will fail to satisfy this characteristic of secondary qualities, on color functionalism. For even if it is a false projection to attribute dispositions to look colored to the extra-mental objects in the world,³² so long as these

²⁹Apart from any theoretical view about the metaphysics of color, the claim that bodies could be literally without color will strike one as implausible if one thinks that, e.g., clear panes of glass have the achromatic color *clearness* rather than no color at all.

³⁰Needless to say, a body that has the property that disposes it to look red to *S* in *C* can be moved to alternative circumstances under which it will not manifest the disposition its color confers upon it (say, circumstances in which the lights are turned off). But this is not to say that the body has lost its color — only that its color can be obscured in some viewing circumstances.

³¹ As [Rickless(1997)Rickless] argues, it is far from clear that Locke, in particular, endorses the view that secondary qualities are unreal. The strongest evidence that he does believe this comes from his claim that “Such qualities, which in truth are nothing in the objects themselves, but powers to produce various sensations in us by their primary qualities . . . , these I call *secondary* qualities” ([Locke(1975)Locke], II, 8, §10). Of course, those who take Locke here to be endorsing irrealism about secondary qualities are faced with the problem of reconciling this view with his claim that secondary qualities are powers that bodies have. Even apart from this, it is arguable that the force of the quoted passage is to insist that secondary qualities are *nothing but* — *i.e.*, *nothing other than* — *powers to produce sensations* (as opposed to: *nothing in the object, but rather powers to produce sensations*).

³²It’s less than obvious that even this much is true; for while we may project the disposition onto an external object on the strength of evidence delivered from inside our own heads, it is nonetheless true (assuming we are right about what happens inside our own heads) that the external object really has the disposition we attribute to it. Of course, it might or might not be erroneous to suppose, on the strength of our projection of the disposition to *x*, that *x* has a numerically distinct property that serves as the basis for the disposition. The quotations from Boyle above suggest that the erroneous projection he had in mind might have been this latter projection of a basis property. I do not see this possibility in Galileo; rather, it seems that he regarded the attribution of the disposition as a false projection. As noted (note 31),

dispositions are non-bare, it will remain true that the properties that confer these dispositions on their bearers do inhere in the extra-mental objects. Thus, if colors are the properties that dispose their bearers to look colored, then colors fail to satisfy this criterion of secondary qualities.

Non-fundamentality Secondary qualities are not fundamental in either their constitution or their causal powers, while primary qualities are fundamental in both. Secondary qualities are constituted by primary qualities, and derive their causal powers from those of primary qualities.

While I believe all the other criteria for the primary/secondary quality distinction we have considered show that functionalism is a primary quality theory of color, I think the present criterion is indecisive. This is because being derivative in constitution and causal powers is a relative matter — we can say that the constitution and causal powers of x are derivative on those of y , but (except perhaps at some very low level — at least at a subatomic level not under consideration in the present discussion) no property is absolutely fundamental in its constitution and causal powers. Of course, if colors are dispositions to look colored, as per a traditional secondary quality view, then it is natural to say that the constitution and causal powers of the colors are derivative on the constitution and causal powers of their bases. But, on the other hand, even the constitution and causal powers of the shape of a middle-sized object — a paradigm primary quality if ever there were one — are derivative on those of its molecules.

What this means is that, when we are restricted to comparing traditional primary and secondary quality views about color, the present criterion distinguishes cleanly between the theories. But things become more complicated when we begin to consider color functionalism, which makes the colors intermediate in their constitution and causal power between the dispositions and the bases for the dispositions.

Color functionalism says that colors are the properties that dispose their bearers to look colored. If so, then things have their dispositions to look colored in virtue of having their colors, so colors are just the properties that constitute the dispositions and confer upon them whatever causal power they may be said to have. Thus, relative to the dispositions to look colored, the colors themselves will be fundamental in their constitution and causal powers. On the other hand, as noted in §1, the property that disposes its bearers to look colored is a higher order functional property. If so, then the colors are derivative in their constitution and causal powers as well — they are derivative on the constitution and causal powers of the first-order structural configurations that realize the colors in each world.

Should we say that functionalism is a secondary quality theory because it makes the constitution and causal powers of colors derivative on those of its realizers (just as a theory that identifies the colors with dispositions to look colored is a secondary quality theory because it makes the constitution and causal powers of colors derivative on those of the bases of the dispositions)? Or should we say that functionalism is a primary quality theory because it makes the constitution and causal powers of the colors more fundamental than those of the dispositions (just as a theory that identifies colors with the bases of the dispositions is a

it is unclear that Locke thought of color attributions as erroneous projections of any kind.

primary quality theory because it makes the constitution and causal powers of the colors more fundamental than those of the dispositions)?

I see no principled choice between these alternatives, and therefore conclude that the criterion we are now considering is indecisive with respect to the question whether color functionalism is a primary or a secondary quality theory. I therefore propose to put it aside.

I do not claim to have provided an exhaustive inventory of the characteristic features of secondary qualities. However, I think the features we have considered form a reasonable core for testing whether a particular quality should count as primary or secondary, as these notions were introduced into philosophical usage. Since all of the criteria in this core that yield a decisive verdict classify functionalism as a primary quality theory, I think it fair to conclude that, on any more or less orthodox construal of these notions, the functionalist understanding of color I have recommended makes color a primary, rather than a secondary, quality.

However, this assessment suggests the need for terminological revision. Since our analysis reveals that the technical term ‘primary quality theory’ applies not only to the views traditionally discussed under that label, but also to color functionalism, it will simplify matters to refer to traditional primary quality theories by the label ‘specificationalist theories of color’.³³ Similarly, I shall refer to traditional secondary quality theories by the label ‘dispositionalist theories of color’. With these labels in hand, I’ll now turn to the task of comparing color functionalism against specificationalism and dispositionalism about color.

3 Functionalism and Its Rivals: A Comparison

Several people have suggested to me that the functionalism of §1 collapses into either a dispositionalist or a specificationalist view of color. In this section, I shall argue that this assessment is inaccurate — that functionalism is distinct from, and indeed superior to, either of its more traditional rivals.

3.1 Functionalism and Dispositionalism

Dispositionalism, which is perhaps the most widely held view of the nature of color, identifies colors with dispositions to look colored. Thus, according to dispositionalism, *red* is the disposition to look red, and *green* is the disposition to look green (*mutatis mutandis* for the other colors).³⁴ One respect in which functionalism and dispositionalism are similar is that both draw a tight connection between the nature of color properties and color experience: both analyze *red* in terms of *looks red*, and understand the latter in terms of a certain class of color experiences (see §1.3). Another

³³This label is chosen to remind us that these theories confidently specify the particular structures that (they hold) are identical with the colors. I choose not to rely on the (increasingly popular) label ‘physicalism’ for such accounts of color, because the idea that colors are physical properties is orthogonal to the main lines of contrast I am attempting to draw (see §1.1).

³⁴Such dispositionalist theories have been advocated by many, including Locke, Galileo, and Descartes; more recent dispositionalists include [McGinn(1983)McGinn], [Peacocke(1984)Peacocke], [Wright(1992)Wright], and [Johnston(1992)Johnston]. I think it is fair to say that color dispositionalism is the received philosophical view on the nature of color.

respect in which the theories are similar is that they both analyze colors in terms of functional roles: since dispositions are multiply realizable functional properties, the functionalist and the dispositionalist agree that colors are multiply realized functional properties of one sort or another.³⁵

However, functionalism and dispositionalism cannot be identified. Dispositionalism says that colors are numerically identical to the dispositions things have to look colored. Functionalism denies this, and says that the colors are some other properties, numerically distinct from the dispositions to look colored, in virtue of which things have their dispositions to look colored. To set this contrast in greater relief, notice that color functionalism stands to color dispositionalism in roughly the same relation that functionalism in the philosophy of mind (as a theory about the individuation of mental states) bears to behaviorism. Recall that, according to behaviorism, mental states are nothing over and above dispositional relations between perceptual input and manifest behavior. Functionalism about mental states, in contrast, holds that mental states are real internal states of minds that, although typically causally connected with input and output, are numerically distinct from the dispositional relations to input and output. Similarly, whereas the color dispositionalist claims that x 's color just is x 's disposition to look colored, color functionalism has it that x 's color is a real property of x that, though it disposes x to look colored, is numerically distinct from x 's disposition to look colored.

A further difference between the two positions concerns the views they take regarding eliminativism about color: while the functionalist can say that (at least one sort of) color eliminativism is genuinely possible albeit factually erroneous, the dispositionalist has no choice but to regard this kind of eliminativism as necessarily false. To see this point, consider the eliminativist conception of color defended by [Hardin(1988)Hardin] and [Boghossian and Velleman(1989)Boghossian and Velleman], among others. These eliminativists hold that, in the actual world, things are not colored. Of course, they do not hold the absurd position that things in the actual world lack dispositions to look colored. It is just that, according to them, having these dispositions is not sufficient for being colored. These eliminativists hold, then, that nothing in the actual world is colored, even though many things in the actual world have the dispositions to look colored. It will be helpful to decompose the eliminativist's thesis into two components:

(B1) Some possible worlds are 'eliminativist worlds' — worlds where things have their dispositions to look colored but are in fact not colored.

(B2) The actual world, α , is an eliminativist world.

Color eliminativism can be regarded as the conjunction of (B1) and (B2).

What should the functionalist say about this view? She will, of course, deny that it is correct: as a color realist, she will deny any claim to the effect that things in our world are not colored. On the other hand, she can understand eliminativism as possibly true. She will say that (B1), the first component of eliminativism, is possibly true because functionalism allows for possible worlds in which things have their dispositions to look colored, but lack any (numerically distinct) property that disposes them to look colored — worlds where the dispositions to look colored are "bare" or "unconstituted". On functionalism, then, (B1) is possible. Moreover, (B2), the second component of color eliminativism, is possible as well: it is possible that α is an eliminativist world. For the functionalist, this is so just in case objects' dispositions to look colored are bare in α . However, the functionalist will go on to say, it is a matter of (metaphysically or

³⁵See [Yablo(1995)Yablo] on the idea that dispositionalism is a kind of functional analysis.

nomologically) contingent fact that the relevant dispositions are non-bare in α , and therefore it is a matter of contingent fact that (B2) is false. Consequently, she can say that the eliminativist has gone factually wrong in describing the actual world, but has said nothing whose truth is not possible.

In contrast, a dispositionalist must accuse the eliminativist of (not factual error, but) necessary falsity. It might seem obvious that a dispositionalist will be forced to regard (B1), and therefore color eliminativism taken as a whole, as incoherent. After all, if colors just are dispositions to look colored, then how could there be a world where things have their dispositions to look colored but are not colored? On second glance, however, it appears that the dispositionalist can capture the coherence of (B1). She can distinguish between the disposition to look colored in α , on the one hand, and the disposition to look colored in the world of evaluation, on the other. The idea would be that ordinary thought and talk about color doesn't distinguish these two sorts of dispositions, since the world of evaluation is ordinarily identical to α , and that further stipulation is needed to fix our intuitions about the abstruse cases that come up in metaphysical debates about color (such as eliminativist worlds). Having made this distinction, the dispositionalist can read (B1) as:

(B1') There are possible worlds w_1, \dots, w_n such that things in w_i exemplify dispositions to look colored in w_i , but lack dispositions to look colored in α .

Since the two dispositions mentioned in (B1') will fail to coincide in all possible worlds, (B1') is coherent (and true).

Unfortunately, while the present move gives the dispositionalist a coherent reading of (B1), it does not make available a consistent reading of (B2), the second component of eliminativism. (B2) asserts that α is an eliminativist world. But given the dispositionalist's construal of eliminativist worlds as per (B1'), it appears that we can only read this assertion as:

(B2') α is a world such that things in α exemplify dispositions to look colored in that world (viz., α), but lack dispositions to look colored in α .

And (B2') is inconsistent.

Of course, the reason (B2') is inconsistent is not that the two dispositions it mentions (the disposition to look red in world w , the disposition to look red in α) cannot be conceptually distinguished in α . They *can* be conceptually distinguished in α ; we make this conceptual distinction by considering a world $w \neq \alpha$ such that the dispositions come apart in w . That is why the dispositionalist can give a coherent reading to (B1) (namely, (B1')). The reason (B2) comes out inconsistent when read as (B2') is that (B2') claims that the two dispositions come apart in α ; and to assess this sort of claim, worlds other than α are irrelevant.

Consider this analogy. Contrast the property $P_1 = \textit{being the shortest spy in } w$ with the property $P_2 = \textit{being the shortest spy in } \alpha$. It is not incoherent (or even false) to assert in α that the bearer of P_2 might have been different from the bearer of P_1 ; we show that this assertion is true by finding some possible world w such that the two properties come apart in w (of course, the bearer of P_2 is the same individual in all worlds, so the world w we use to verify the assertion cannot be identical to α). On the other hand, worlds other than α are irrelevant to the assessment of the claim that α is a world where the two properties come apart. Without considering non-actual worlds, we know that this second claim is inconsistent because it is equivalent to the conjunction of these three mutually inconsistent claims: (i) x is the the shortest spy in w , (ii) x is not the shortest spy in α , (iii) $w = \alpha$.

Likewise, without considering non-actual worlds, we know that (B2') is inconsistent because it is equivalent to the conjunction of these three mutually inconsistent claims: (i) things exemplify the disposition to look colored in w , (ii) things do not exemplify the disposition to look colored in α , (iii) $w = \alpha$.

Thus, the dispositionalist, unlike the functionalist, must regard eliminativism as inconsistent, and therefore necessarily false. Since functionalism and dispositionalism come apart in their verdicts about eliminativism, they cannot be identified.³⁶

For these reasons, I suggest that color functionalism must be distinguished from color dispositionalism, despite the similarities between the two views.

3.2 Why Be A Functionalist, Part I: Dispositionalism

Having argued that color functionalism should be distinguished from color dispositionalism, I now want to argue for the superiority of the former view over the latter. However, before I discuss the reasons I have for thinking functionalism is superior to dispositionalism, I want to consider, briefly, two lines of argument for the same conclusion that I do not find convincing.

The first such argument involves the allegation that functionalism sidesteps a phenomenological objection that has been pressed against dispositionalism. The objection in question builds on the claim that, while manifestations of dispositions may be direct objects of our seeing, dispositions themselves may not. But, the objector continues, since colors are *visibilia par excellence* — since they are paradigm examples of properties that can be direct objects of seeing, it follows that colors cannot be dispositions:

When you look at an object you do not see (de dicto) its dispositions to act in certain ways in certain circumstances, but you do see what color it is. Here, of course, I mean direct object perception, not just seeing-that — seeing the property itself, not merely seeing that it is instantiated. You may see *that* something is soluble by watching it dissolve, but you do not see its solubility — that property itself. You can see the manifestation of the disposition, and you may also see the categorical basis of the disposition in the object's molecular structure, but your eyes do not acquaint you with the property of being *disposed* to dissolve. . . . And now the point about colors is that they enter the very content of primitive visual experience, being part of how objects appear, but dispositions of whatever kind cannot themselves enter visual content in this way ([McGinn(1996)McGinn], 540; cf. [Mackie(1976)Mackie], chapter 1).

Some authors ([McLaughlin(2003)McLaughlin], for example) have suggested that this objection works in favor of functionalism, because even if the disposition to look red cannot be the direct object of seeing (that is, even if the disposition itself is not visible), there seems no reason to say that the property that disposes its bearers to look red cannot be the direct object of seeing. Consequently, the thought goes, functionalism can preserve the visibility of the colors, even if dispositionalism cannot.³⁷

³⁶If functionalism and dispositionalism disagree about the possibility of cases where the disposition is instantiated but the color is not, they might also disagree about the possibility of cases where the color is instantiated but the disposition is not. If such cases are possible, then, they will make for a further point of distinction between the two views. I am reluctant to appeal to such cases since I am not sure that they are possible.

³⁷McLaughlin doesn't put too much weight on this point in advocating functionalism over dispositionalism, however, since he thinks the objection is ultimately ineffective against both views.

But I am unconvinced that functionalism is any better off in this regard than dispositionalism for two reasons. First, functionalism leaves it open that the colors — the properties that dispose their bearers to look colored — might themselves be dispositions. Therefore, the threat of the invisibility of dispositions leaves the functionalist, too, in the undesirable position of admitting that colors might be invisible. And second, functionalism leaves it open that colors are disjunctive (in the actual world), and we might worry that the present objection concerning the invisibility of dispositions would apply to disjunctions as well: one might object that, while a disjunct can be the direct object of seeing (that it can be visible), a disjunctive property built from that disjunct cannot. All this suggests to me that the present objection is just as threatening to functionalism as it is to dispositionalism.

On the other hand, I am not persuaded to abandon functionalism (nor would I be persuaded to abandon dispositionalism, if I held that view) by the objection we have been considering. This is because I believe that if colors are dispositions, then they are dispositions that (unlike *solubility*) can be the direct objects of seeing. The objection we are discussing allows that manifestations of dispositions can be direct objects of seeing, but insists that dispositions themselves cannot; for example, while we can see (in the direct object sense) a dissolution, we cannot see (in the direct object sense) *solubility*. However, I think this overlooks relevant differences between dispositions, some of which can be the direct object of seeing, and some of which cannot. Namely, I suggest that a disposition can be a direct object of seeing if it is a disposition whose manifestation is a visual experience. For in that case, when the disposition manifests, what happens is constitutive of seeing the disposition. But both of the views threatened by the present objection (functionalism and dispositionalism) have it that, if *red* is a disposition, it is a disposition whose manifestation is a visual experience. Consequently, if what I have suggested is correct, both of these views can explain how it is that *red* is visible, even if they take that property to be a disposition.³⁸ In contrast, the dispositionalist and the functionalist can agree, there are many invisible dispositions: for example, since the manifestation of *solubility* is not a visual experience, but a dissolution, and since dissolution is not constitutive of seeing *solubility* (the two are not even coextensive — there could be a dissolution without any perceivers being present, or even existing), the present answer will not make *solubility* a possible direct object of seeing. If this is right, then functionalism and dispositionalism are safe from the objection we have considered.³⁹

³⁸My claim here is not that we see the disposition by seeing the visual experience that is the manifestation of the disposition — for I deny that we see our visual experiences (in the direct object sense at issue). Rather, I claim that the visual experience itself (when it is appropriately caused by something to which we are visually attending) is the manifestation of the disposition, and that undergoing such a visual experience *constitutes* seeing the disposition (in the direct object sense at issue).

³⁹Some have responded to the present objection by holding that that ‘sees’ introduces a hyperintensional context (similarly for ‘looks’) — one where sameness of sense and reference does not guarantee intersubstitutability *salva veritate*, so that the proposed analytic equivalence between ‘red’ and ‘the property that disposes its bearers to look red’ leaves it open that ‘I see red’ may be true while ‘I see the property that disposes its bearers to look red’ may be false (I believe this proposal originates in ([McGinn(1983)McGinn], 133–135), although McGinn repudiates it in [McGinn(1996)McGinn]; the hyperintensionality response is endorsed in [McLaughlin(2003)McLaughlin]). But I find this answer unconvincing: while it is plausible that ‘looks’ may introduce a hyperintensional context, my intuition is not only that the context created by ‘sees’ is not hyperintensional, but that it is *extensional*. If so, the hyperintensionality proposal cannot speak to the present objection, which concerns whether

A second argument for preferring functionalism over dispositionalism that is unconvincing to me is grounded in the idea that, since colors must be causally efficacious (e.g., in order to be the causes of our color experiences), and since dispositions cannot be causally efficacious, colors cannot be dispositions.⁴⁰ The reason I find this motivation unpersuasive is that I don't see why the causal link between colors and color experiences might not be understood in terms of a weaker, more derivative sort of causation (something like what some philosophers have called causal relevance or program causation) such that dispositions could be causes in this weaker sense. I don't see that our intuitions about the causal efficacy of colors come with any philosophically explicit unpacking of what this efficacy amounts to, and therefore I don't see why these intuitions demand a kind of causal efficacy that dispositions cannot have instead of a kind of causal efficacy that dispositions can have. If they do not, then they give us no reason to doubt that colors could be dispositions.⁴¹

For these reasons, I regard these arguments from the visibility and causal efficacy of colors as unsuccessful in motivating color functionalism over color dispositionalism. However, I believe there are other arguments that make that case more successfully.

A first is that functionalism does, but dispositionalism does not, preserve the following pre-theoretically plausible intuition about the effects of colors:

(C) Colors endow things with their dispositions to look colored.⁴²

The functionalist can endorse (C) straightforwardly; for, according to functionalism, colors are precisely those properties in virtue of which things have their dispositions to look colored — they are the properties (numerically different from the dispositions themselves) that dispose their bearers to look colored. In contrast, the dispositionalist cannot agree with (C) since she holds that the colors are dispositions to look colored, and since it seems wrong to say that the dispositions to look colored endow things with their dispositions to look colored. A dispositionalist might respond to this argument by an appeal to pragmatics: she might insist that the dispositions to look colored really do endow things with their dispositions to look colored (and thus that (C) is true), and explain our disinclination to say that this is so as a violation of conversational maxims enjoining informativeness. But this proposed line of explanation is implausible insofar as we are, I take it, inclined to endorse (C) as a non-trivial, if mundane, fact about colors. If (C) could be secured only by the trivial and uninformative fact that things have the dispositions to look colored by virtue of having precisely those dispositions, then (C) itself should strike us as trivial and uninformative, which it seems not to. The upshot, it seems to me, is that functionalism squares better with pre-theoretical intuition than does dispositionalism.

colors can be the direct objects of 'sees'.

⁴⁰This is the reason Frank Jackson has given for rejecting dispositionalism in [Jackson and Pargetter(1987)Jackson and Pargetter], [Jackson(1996)Jackson], and [Jackson(1998b)Jackson]. See also [Yablo(1995)Yablo], 482.

⁴¹I consider these arguments in more detail in [Cohen(2000)Cohen], chapter 3. See also [McFarland and Miller(1998)McFarland and Miller], [Jackson(1998a)Jackson], and [McFarland and Miller(2000)McFarland and Miller].

⁴²The worry here is not, as in the objection considered above, that colors understood as dispositions would be without causal powers; as I said above, I am not moved by this allegation. Indeed, I am not even claiming that the endowment in question is causal (plausibly it is a constitution relation of some sort rather than a causal relation, although I take no official stand on this matter). Even if the relation is causal, the worry presented by (C) still need not reduce to the thought that dispositions lack causal powers in general; a separate and independent worry would be that colors understood as dispositions lack the particular causal power of endowing things with their dispositions to look colored.

A final point in favor of functionalism is that functionalism does, while dispositionalism does not, respect the intuition that things might have been disposed to look colored without being colored. As noted in §3.1, eliminativists claim the actual world is one in which things are disposed to look colored but are not colored. Even if we hold that eliminativism is false, as I think we should, it seems plausible that it is possibly true: even if the actual world α is not a world where things look colored but are not colored, it is possible that α is such a world.⁴³ Again, as we have seen, the functionalist can accept this diagnosis, since she admits that that things might have had their dispositions to look colored without having any *other* property in virtue of which they have those dispositions. But, if the argument in §3.1 is sound, the dispositionalist must regard eliminativism as necessarily false. Once again, then, it seems that functionalism respects our intuitions about color in a way that dispositionalism does not.

3.3 Functionalism and Specificationalism

If color functionalism stands to color dispositionalism as functionalism stands to behaviorism in the philosophy of mind (see §3.1), color functionalism should also be distinguished from views about color that are analogous to identity theories in the philosophy of mind. These latter theories about color, which I have called specificationalist theories, hold that colors are identical to the particular structures that, in the actual world, dispose their bearers to look colored.

One of the most explicit and vigorously defended forms of specificationalism is that of [Hilbert(1987)Hilbert] and [Byrne and Hilbert(1997a)Byrne and Hilbert], on which colors are anthropocentric classes of spectral reflectance distributions. This is clearly a specificationalist theory, since it says that the colors are identical to particular structures, independently of whether these structures happen to play the functional role of disposing their bearers to look colored.⁴⁴ Other (less explicit) specificationalist accounts are proposed in [Kripke(1980)Kripke], 140, note 71, and [Armstrong(1968)Armstrong], chapter 12. What unites different forms of specificationalism is a commitment to the claim that the functional roles colors have *vis-a-vis* visual systems are only contingent features of those properties: properties that lacked those functional roles could still be colors, and colors could lack those functional roles without thereby ceasing to be colors. It is this claim that is denied by functionalism, on which color properties are the properties that dispose their bearers to look colored. For the functionalist, any property occupying this functional role is, *ipso facto* a color property, and any property lacking this functional role, *ipso facto*, is not a color property.⁴⁵

⁴³So it has seemed to most who have considered these matters. For a dissenting view, see [Stroud(2000)Stroud]. For an argument that Stroud's dissent is misplaced, see [Cohen(2003)Cohen].

⁴⁴However, this particular specificationalism does pick out the colors in terms of (perceiver-independent) functions: surface spectral reflectance distributions represent the functional property of reflecting particular percentages of incident light at each frequency throughout the range of visible wavelengths. Nonetheless, since the functional role in question is independent of any function *vis-a-vis* how things look to perceivers, I'm counting this as a specificationalist theory.

⁴⁵Notice, however, that it is (in principle) possible for functionalists to agree that some specificationalist proposal is the correct account of the *actual* colors; some version of specificationalism may well succeed in picking out the mechanism that actually, in our world, fills the functionalist's functional role. (The parenthetical qualification is needed since, of course,

3.4 Why Be A Functionalist, Part II: Specificationalism

We should prefer a functionalist over a specificationalist theory of color because of an empirical result already mentioned: there is no particular physical structure that is had by all and only red things (or all and only yellow things, or all and only teal things, etc.). Rather, the class of physical structures that are red, even in the actual world, seems to form a rather heterogeneous collection from the perspective of physical science; *red* is, in the standard jargon, multiply realized. To continue an analogy with the philosophy of mind appealed to in §3.1 and §3.3, notice that the multiple realizability of *pain* has often been thought to impugn identity theories of *pain*; so too, then, the multiple realizability of *red* is a *prima facie* objection against specificationalist theories of color.⁴⁶ However, just as the identity theorist about *pain* can respond to worries about multiple realizability by claiming that pain is identical to a disjunctive physical type whose disjuncts are the various multiple realizations, the specificationalist can hold that, while *red* is identical to a physical type, it is identical to a motley and disjunctive physical type. But if this appeal to disjunctions is to effect a principled, rather than *ad hoc*, grouping — if we want to know why one of the relevant material structures does count as a realization of *red* but my grandmother does not, we need to explain why the various disjuncts are all gathered together into the type identified with *red*. However, given the physical heterogeneity of the disjuncts, the answer cannot be given in physical terms — since the collection is physically motley, there is no physical criterion whose presence or absence makes it the case that a putative disjunct is or is not one of the realizers of *red*. Rather it seems that the disjuncts all count as ways of being red because they all play the functional role of disposing their bearers to look red. However, to say this is to admit that what makes a particular structure count as an instance of *red* is not what sort of a physical structure it is, but rather that that structure plays the functional role of disposing its bearers to look red. Of course, to say this is to adopt a functionalist, rather than a specificationalist, analysis of *red*.

4 Conclusion

In this paper I have attempted to lay out color functionalism (§1), to locate that view with respect to the historical background in which it falls (§2), and to contrast and defend it against its principal contemporary competitors (§3). I believe that functionalism inherits advantages of more widely discussed proposals without suffering from their drawbacks, and that it is a plausible account of the nature of color. At the

existing specificationalist theories may *not* succeed in picking out the actual physical properties that dispose their bearers to look colored.) Indeed, I'm inclined to think of something like the specificationalism of [Hilbert(1987)Hilbert] in just this way — as a plausible special case of the correct functionalist theory of color, when the latter is restricted to the actual colors, and only insofar as attention is restricted to surface colors.

⁴⁶One disanalogy (that works in my favor) is that, while multiple realizability objections about *pain* often turn on notoriously unstable intuitions about what we would call states of non-human creatures such as octopi and worms (and often on even less stable intuitions about what we would call states of possible Martian creatures), multiple realizability objections about *red* depend on only the claim that the extension of that property is physically heterogeneous. And this claim follows from the uncontroversial empirical fact that the extension of 'red' as judged by normal adult human beings is physically heterogeneous, together with the reasonable assumption that that class overlaps with the class of red things (at least largely — put borderline cases aside).

very least, I suggest that this view deserves wider philosophical attention than it has received up to now.⁴⁷

References

- [Armstrong(1968)Armstrong] Armstrong, D. (1968). *A Materialist Theory of the Mind*. Routledge, London.
- [Boghossian and Velleman(1989)Boghossian and Velleman] Boghossian, P. A. and Velleman, J. D. (1989). Colour as a secondary quality. *Mind*, **98**, 81–103. Reprinted in [Byrne and Hilbert(1997b)Byrne and Hilbert], 81–103.
- [Bowmaker and Dartnall(1980)Bowmaker and Dartnall] Bowmaker, J. K. and Dartnall, H. J. A. (1980). Visual pigments of rods and cones in a human retina. *Journal Physiologica*, **298**, 501–511.
- [Boyle(1979)Boyle] Boyle, R. (1979). The origins of forms and qualities according to the corpuscular philosophy. In M. A. Stewart, editor, *Selected Philosophical Papers of Robert Boyle*. Barnes and Noble Books, New York.
- [Boynton(1979)Boynton] Boynton, R. M. (1979). *Human Color Vision*. Holt, Rinehart and Winston, New York.
- [Byrne and Hilbert(1997a)Byrne and Hilbert] Byrne, A. and Hilbert, D. R. (1997a). Colors and reflectances. In A. Byrne and D. R. Hilbert, editors, *Readings on Color, Volume 1: The Philosophy of Color*, pages 263–288. MIT Press, Cambridge, Massachusetts.
- [Byrne and Hilbert(1997b)Byrne and Hilbert] Byrne, A. and Hilbert, D. R., editors (1997b). *Readings on Color, Volume 1: The Philosophy of Color*. MIT Press, Cambridge, Massachusetts.
- [Byrne and Hilbert(1997c)Byrne and Hilbert] Byrne, A. and Hilbert, D. R., editors (1997c). *Readings on Color, Volume 2: The Science of Color*. MIT Press, Cambridge, Massachusetts.
- [Chalmers(1996)Chalmers] Chalmers, D. (1996). *The Conscious Mind: In Search of a Fundamental Theory*. Oxford University Press, New York.
- [Cicerone and Nerger(1989)Cicerone and Nerger] Cicerone, C. M. and Nerger, J. L. (1989). The relative number of long-wavelength-sensitive to middle-wavelength-sensitive cones in the human fovea. *Vision Research*, **26**, 115–128.
- [Clark(1993)Clark] Clark, A. (1993). *Sensory Qualities*. Clarendon Press, Oxford.
- [Cohen(2000)Cohen] Cohen, J. (2000). *Color Properties and Color Perception: A Functional Account*. Ph.D. thesis, Rutgers University, New Brunswick, New Jersey.
- [Cohen(2003)Cohen] Cohen, J. (2003). Critical study of Stroud’s Quest for Reality. *Noûs*, **37**(3), 537–554.
- [Cohen(2004)Cohen] Cohen, J. (2004). Color properties and color ascriptions: A relationalist manifesto. *The Philosophical Review*, **113**(4), 451–506.

⁴⁷This paper is a (distant) descendant of the first chapter of my doctoral dissertation, [Cohen(2000)Cohen]. Many thanks to Larry Hardin, Colin McGinn, Mohan Matthen, Brian McLaughlin, Ram Neta, Sam Rickless, and Philip Robbins.

- [Dartnall *et al.*(1983)Dartnall, Bowmaker, and Mollon] Dartnall, H. J. A., Bowmaker, J. K., and Mollon, J. D. (1983). Human visual pigments: microspectrophotometric results from the eyes of seven persons. *Proceedings of the Royal Society of London B*, **220**, 115–130.
- [Davidson(1973)Davidson] Davidson, D. (1973). Freedom to act. In T. Honderich, editor, *Essays on Freedom of Action*. Routledge & Kegan Paul, London. Reprinted in [Davidson(1980)Davidson], 63–81.
- [Davidson(1980)Davidson] Davidson, D. (1980). *Essays on Action and Events*. Clarendon Press, Oxford.
- [Dretske(1995)Dretske] Dretske, F. (1995). *Naturalizing the Mind*. MIT Press, Cambridge, Massachusetts. Originally delivered as the 1994 Jean Nicod Lectures.
- [Galileo(1989)Galileo] Galileo (1989). The assayer (1623). In M. R. Matthews, editor, *The Scientific Background to Modern Philosophy: Selected Readings*, pages 56–61. Hackett Publishing, Indianapolis.
- [Gold(1999)Gold] Gold, I. (1999). Dispositions and the central problem of color. *Philosophical Studies*, **93**(1), 21–44.
- [Hagstrom *et al.*(1998)Hagstrom, Neitz, and Neitz] Hagstrom, S., Neitz, J., and Neitz, M. (1998). Variation in cone populations for red-green color vision exemplified by analysis of mRNA. *NeuroReport*, **9**, 1963–1967.
- [Hardin(1988)Hardin] Hardin, C. L. (1988). *Color for Philosophers: Unweaving the Rainbow*. Hackett, Indianapolis.
- [Harman(1990)Harman] Harman, G. (1990). The intrinsic quality of experience. In J. Tomberlin, editor, *Philosophical Perspectives: Action Theory and Philosophy of Mind*, volume 4, pages 31–52. Ridgeview Publishing Company, Atascadero, California.
- [Harman(1996)Harman] Harman, G. (1996). Explaining objective color in terms of subjective reactions. In E. Villanueva, editor, *Philosophical Issues*, volume 7. Ridgeview, Atascadero, California. Reprinted in [Byrne and Hilbert(1997b)Byrne and Hilbert], 247–261.
- [Hilbert(1987)Hilbert] Hilbert, D. R. (1987). *Color and Color Perception: A Study in Anthropocentric Realism*. CSLI, Stanford.
- [Hilbert(1992a)Hilbert] Hilbert, D. R. (1992a). Comparative color vision and the objectivity of color: Open peer commentary on [Thompson *et al.*(1992)Thompson, Palacios, and Varela]. *Behavioral and Brain Sciences*, **15**, 38–39.
- [Hilbert(1992b)Hilbert] Hilbert, D. R. (1992b). What is color vision? *Philosophical Studies*, **68**, 351–370.
- [Hill(1991)Hill] Hill, C. S. (1991). *Sensations*. Cambridge University Press, Cambridge.
- [Hurvich(1981)Hurvich] Hurvich, L. M. (1981). *Color Vision*. Sinauer Associates, Sunderland, Massachusetts.
- [Jackson(1977)Jackson] Jackson, F. (1977). *Perception: A Representative Theory*. Cambridge University Press, New York.
- [Jackson(1996)Jackson] Jackson, F. (1996). The primary quality view of color. *Philosophical Perspectives*, **10**, 199–219.

- [Jackson(1998a)Jackson] Jackson, F. (1998a). Colour, disjunctions, programmes. *Analysis*, **58**, 86–88.
- [Jackson(1998b)Jackson] Jackson, F. (1998b). *From Metaphysics to Ethics: A Defence of Conceptual Analysis*. Oxford, New York. Originally given as the 1998 Locke Lectures.
- [Jackson and Pargetter(1987)Jackson and Pargetter] Jackson, F. and Pargetter, R. (1987). An objectivist’s guide to subjectivism about color. *Revue Internationale de Philosophie*, **160**, 127–141. Reprinted in [Byrne and Hilbert(1997b)Byrne and Hilbert], 67–79.
- [Jacobs and Deegan(1997)Jacobs and Deegan] Jacobs, G. H. and Deegan, J. F. (1997). Spectral sensitivity of macaque monkeys measured with ERG flicker photometry. *Visual Neuroscience*, **14**, 921–928.
- [Jacobs and Neitz(1993)Jacobs and Neitz] Jacobs, G. H. and Neitz, J. (1993). Electrophysiological estimates of individual variation in the L/M cone ratio. In B. Drum, editor, *Colour Vision Deficiencies*, volume XI of *Documenta Ophthalmologica Proceedings Series 56*, chapter 11, pages 107–112. Kluwer Academic Publishers, Dordrecht.
- [Johnston(1992)Johnston] Johnston, M. (1992). How to speak of the colors. *Philosophical Studies*, **68**, 221–263.
- [Kripke(1980)Kripke] Kripke, S. (1980). *Naming and Necessity*. Harvard University Press, Cambridge, Massachusetts.
- [Lewis(1997)Lewis] Lewis, D. (1997). Naming the colors. *Australasian Journal of Philosophy*, **75**(3), 325–342.
- [Locke(1975)Locke] Locke, J. (1975). *An Essay Concerning Human Understanding (1689)*. Oxford University Press, New York.
- [Mackie(1976)Mackie] Mackie, J. L. (1976). *Problems from Locke*. Oxford University Press, Oxford.
- [Matthen(1999)Matthen] Matthen, M. (1999). The disunity of color. *The Philosophical Review*, **108**(1), 47–84.
- [McDowell(1985)McDowell] McDowell, J. (1985). Values and secondary qualities. In T. Honderich, editor, *Morality and Objectivity: A Tribute to J. L. Mackie*, pages 110–129. Routledge & Kegan Paul, London.
- [McFarland and Miller(1998)McFarland and Miller] McFarland, D. and Miller, A. (1998). Jackson on colour as a primary quality. *Analysis*, **58**, 76–85.
- [McFarland and Miller(2000)McFarland and Miller] McFarland, D. and Miller, A. (2000). Disjunctions, programming, and the Australian view of colour. *Analysis*, **60**(2), 209–212.
- [McGinn(1983)McGinn] McGinn, C. (1983). *The Subjective View: Secondary Qualities and Indexical Thoughts*. Oxford University Press, Oxford.
- [McGinn(1996)McGinn] McGinn, C. (1996). Another look at color. *The Journal of Philosophy*, **93**(11), 537–553.
- [McLaughlin(1995)McLaughlin] McLaughlin, B. (1995). Disposition. In J. Kim and E. Sosa, editors, *A Companion to Metaphysics*, pages 121–124. Basil Blackwell, Oxford.

- [McLaughlin(2003)McLaughlin] McLaughlin, B. (2003). The place of color in nature. In R. Mausfeld and D. Heyer, editors, *Colour Perception: Mind and the Physical World*, pages 475–502. Oxford University Press, New York.
- [Nassau(1980)Nassau] Nassau, K. (1980). The causes of color. *Scientific American*, **243**, 124–154. Reprinted in [Byrne and Hilbert(1997c)Byrne and Hilbert], 3–29.
- [Peacocke(1979)Peacocke] Peacocke, C. (1979). Deviant causal chains. *Midwest Studies in Philosophy*, **4**, 123–155.
- [Peacocke(1984)Peacocke] Peacocke, C. (1984). Colour concepts and colour experiences. *Synthese*, **58**(3), 365–381. Reprinted in [Rosenthal(1991)Rosenthal], 408–416.
- [Pokorny *et al.*(1991)Pokorny, Smith, and Wesner] Pokorny, J., Smith, V. C., and Wesner, M. (1991). Variability in cone populations and implications. In A. Valberg and B. B. Lee, editors, *From Pigments to Perception*, pages 23–34. Plenum, New York.
- [Pylyshyn(1989)Pylyshyn] Pylyshyn, Z. W. (1989). The role of location indexes in spatial perception: A sketch of the FINST spatial-index model. *Cognition*, **32**, 65–97.
- [Pylyshyn(1994)Pylyshyn] Pylyshyn, Z. W. (1994). Some primitive mechanisms of spatial attention. *Cognition*, **50**, 363–384.
- [Quine(1953)Quine] Quine, W. V. O. (1953). Two dogmas of empiricism. In W. V. O. Quine, editor, *From a Logical Point of View*. Harper and Row, New York. Originally in *The Philosophical Review*, 1951.
- [Rickless(1997)Rickless] Rickless, S. C. (1997). Locke on primary and secondary qualities. *Pacific Philosophical Quarterly*, **78**, 297–319.
- [Roorda and Williams(1999)Roorda and Williams] Roorda, A. and Williams, D. R. (1999). The arrangement of the three cone classes in the living human eye. *Nature*, **397**, 520–522.
- [Rosenthal(1991)Rosenthal] Rosenthal, D. (1991). *The Nature of Mind*. Oxford University Press, New York.
- [Rushton and Baker(1964)Rushton and Baker] Rushton, W. A. H. and Baker, H. D. (1964). Red/green sensitivity in normal vision. *Vision Research*, **4**, 75–85.
- [Sellars(1956)Sellars] Sellars, W. (1956). Empiricism and the philosophy of mind. In H. Feigl and M. Scriven, editors, *Minnesota Studies in the Philosophy of Science*, volume 1, pages 253–329. University of Minnesota Press, Minneapolis.
- [Sellars(1963)Sellars] Sellars, W. (1963). Philosophy and the scientific image of man. In W. Sellars, editor, *Science, Perception and Reality*, pages 1–40. Routledge & Kegan Paul, London.
- [Stroud(2000)Stroud] Stroud, B. (2000). *The Quest for Reality: Subjectivism and the Metaphysics of Colour*. Oxford University Press, New York.
- [Thompson *et al.*(1992)Thompson, Palacios, and Varela] Thompson, E., Palacios, A., and Varela, F. (1992). Ways of coloring: Comparative color vision as a case study for cognitive science. *Behavioral and Brain Sciences*, **15**, 1–74.
- [Tye(1995)Tye] Tye, M. (1995). *Ten Problems of Consciousness: A Representational Theory of the Phenomenal Mind*. MIT Press, Cambridge, Massachusetts.

- [Vimal *et al.*(1989)Vimal, Pokorny, Smith, and Shevell] Vimal, R. L. P., Pokorny, J., Smith, V. C., and Shevell, S. K. (1989). Foveal cone thresholds. *Vision Research*, **29**, 61–78.
- [Wright(1992)Wright] Wright, C. (1992). *Truth and Objectivity*. Harvard University Press, Cambridge, Massachusetts.
- [Yablo(1995)Yablo] Yablo, S. (1995). Singling out properties. *Philosophical Perspectives*, **9**, 477–502.
- [Yamaguchi *et al.*(1998)Yamaguchi, Motulsky, and Deeb] Yamaguchi, T., Motulsky, A. G., and Deeb, S. S. (1998). Visual pigment gene structure and expression in human retinae. *Human Molecular Genetics*, **6**, 981–990.