

## **INFORMATION TO USERS**

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

**The quality of this reproduction is dependent upon the quality of the copy submitted.** Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

# **UMI**

A Bell & Howell Information Company  
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA  
313/761-4700 800/521-0600



BEING RED AND SEEING RED:  
SENSORY AND PERCEPTIBLE QUALITIES

by

PETER W. ROSS

A dissertation submitted to the Graduate Faculty in  
Philosophy in partial fulfillment of the requirements for  
the degree of Doctor of Philosophy, The City University of  
New York

1997

**UMI Number: 9807993**

**Copyright 1997 by  
Ross, Peter W.**

**All rights reserved.**

---

**UMI Microform 9807993  
Copyright 1997, by UMI Company. All rights reserved.**

**This microform edition is protected against unauthorized  
copying under Title 17, United States Code.**

---

**UMI**  
**300 North Zeeb Road**  
**Ann Arbor, MI 48103**

© 1997

PETER W. ROSS

All Rights Reserved

This manuscript has been read and accepted for the Graduate Faculty in Philosophy in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

June 2, 1997  
Date

Charles Landmesser  
Chair of Examining Committee

June 3, 1997  
Date

Richard Marshall  
Executive Officer

Janet Allen

[Signature]

[Signature]

Anna Kolow

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

AbstractBEING RED AND SEEING RED:  
SENSORY AND PERCEPTIBLE QUALITIES

by

Peter W. Ross

Advisor: Professor David M. Rosenthal

I examine the metaphysical issue of the nature of color. I argue that there are two distinct ranges of colors, namely, physical colors, which are disjunctive monadic physical properties of physical objects, and mental colors, which are properties of neural processes.

A pair of claims provide the motivation for subjectivist and dispositionalist proposals about the nature of color, proposals which I reject. The first claim holds that a description of colors according to our ordinary experience of color provides a specification of some aspects of the nature of color. The second holds that our ordinary experience of color provides access to the nature of color.

In chapter 1, I argue that visual experiences have mental colors, neural properties which importantly determine our color categories. However, I reject C. L. Hardin's and James A. McGilvray's arguments for the subjectivist claim that the colors we attribute to physical objects are mental colors.

In chapter 2, I show that Paul A. Boghossian and J. David Velleman's arguments in support of subjectivism rely on the assumption that visual experience provides unqualified access to the nature of color. I argue, however, that objections to their projectivism about color perception provide strong reasons to reject subjectivism as well as their assumption that visual experience provides unqualified access to the nature of color.

In chapters 3 and 4, I examine Mark Johnston's and Christopher Peacocke's dispositionalist proposals about the nature of physical colors, which are founded on the claim that ordinary visual experience provides access to an aspect of the nature of color. I undercut dispositionalism by rejecting their arguments for the claim that ordinary visual experience provides such access.

In chapter 5, I show that Evan Thompson's proposal that the colors of objects are relations between properties of perceivers and objects assumes that a description of color according to our ordinary experience specifies some aspects of the nature of color. I reject this assumption by distinguishing between mental color and physical color. I conclude that rather than specifying the nature of color, descriptions of colors according to our ordinary experience merely serve to fix the reference of color terms.

### Acknowledgements

My greatest thanks are owed to David M. Rosenthal, whose extraordinary skills as a philosopher, teacher, scholar, and friend were invaluable to me at every step in completing the dissertation, from formulating the initial proposal, to writing grant applications, to preparing for conference presentations. David steered me toward studying color, and his fine mentoring made the development of the dissertation possible. Although a stage of my training has come to an end, I'll always be David's student.

I owe great thanks to Arnold Koslow, who directed my attention to Paul Grice's "Some Remarks about the Senses," and thereby initiated and encouraged work which lead to a dissertation on color and visual experience. I'm also thankful for Arnold's advice and support during the writing of the dissertation. As well, thanks are due to Jonathan Adler for his kind encouragement while I was writing the dissertation.

The Graduate School and University Center of The City University of New York supported my dissertation work with a Dissertation Year Fellowship. I'm very thankful to the Philosophy Program for recommending me for the fellowship and to The Graduate School for this critical financial assistance. The focus that the fellowship allowed was priceless.

Larry Hardin generously shared his knowledge and insights, and also gave me valuable comments on chapter 2, a part of which I presented at the Syracuse University Graduate Philosophy Conference in March 1997. Although we don't arrive at the same results, I'm convinced that his ground-breaking approach to color, involving a rapprochement of philosophical and psychological research, is the most fruitful.

I'm also indebted to Austen Clark for his extremely helpful insights and citations, and his kind words. Austen's mastery of the use of empirical science to support philosophical argument provided inspiration as well as guidance.

Brian McLaughlin very graciously allowed me to present my dissertation as part of his graduate course on color at Rutgers. For this opportunity, as well as the incisive comments that I received from Brian and the members of his class, I'm quite grateful.

I've benefitted tremendously from conversations with Adam Vinueza about color as well as philosophical issues in general. Also, I thank Jonathan Cohen for helpful conversations about color in particular. Saul Fisher and Blake Sypher offered challenging philosophical discussions, and were terrific friends over the course of writing the dissertation.

I'm especially grateful to my wife and colleague Diana Linden for the countless ways in which she has been helpful, patient, and loving. Whether in editing the manuscript or in advising me on points about dissertation writing, she's kept her admirable wit and wisdom. Thanks for being so wonderful.

Dedication

I dedicate this work to the memory of my mother, Elodie  
Loiseaux Ross.

Table of Contents

Copyright . . . . .	ii
Abstract . . . . .	iv
Acknowledgements . . . . .	vi
Dedication . . . . .	ix
Table of Contents . . . . .	x
Introduction . . . . .	1
1. Visual Experience and Sensory Qualities . . . . .	11
1.1. Visual Fields and Sense Data . . . . .	14
1.2. The Representational Properties of Visual Experience . . . . .	16
1.3. The Qualitative Properties of Visual Experience . . . . .	19
1.3.1. Describing Mental Color . . . . .	19
1.3.2. Explaining Mental Color . . . . .	23
1.3.3. The Nature of Mental Color . . . . .	34
1.3.3.1. Clark's Proposal . . . . .	35
1.3.3.2. The Lewisian Alternative . . . . .	38
1.3.4. Motivations for Mental Color . . . . .	43
1.3.4.1. Awareness of Mental Color . . . . .	45
1.3.4.1.1. Afterimage Colors . . . . .	47
1.3.4.1.2. Perceived Colors . . . . .	56
1.3.4.2. The Determination of Color Categories . . . . .	70
1.3.5. Are Physical Objects Colorless? . . . . .	75

Table of Contents	xi
2. Boghossian and Velleman's Subjectivism . . . . .	81
2.1. Arguments against Physical Color . . . . .	82
2.1.1. An Argument against Monadic Physical Color . . . . .	82
2.1.1.1. Boghossian and Velleman's Epistemological Challenge . . . . .	86
2.1.1.2. Boghossian and Velleman's Epistemological Argument . . . . .	88
2.1.1.3. The Physicalist's Response . . . . .	89
2.1.2. Arguments against Dispositionalism . . . . .	97
2.1.2.1. Arguments against Pure and Qualified Dispositionalism . . . . .	99
2.1.2.2. A General Argument against Dispositionalism . . . . .	103
2.1.2.3. The Dispositionalist's Response . . . . .	106
2.2. The Projectivist Theory of Color Perception . . . . .	111
2.2.1. An Argument against Traditional Projectivism . . . . .	114
2.2.2. McGilvray's Alternative Theory . . . . .	119
2.2.3. Problems with McGilvray's Alternative Theory . . . . .	122
2.3. Two Distinct Ranges of Colors . . . . .	129
3. Johnston's Dispositionalism . . . . .	131
3.1. Core Beliefs about Colors . . . . .	132
3.2. Physical Colors . . . . .	139
3.2.1. Visual Experiences of Color . . . . .	142

3.2.2.	Specifying Physical Colors . . . . .	145
3.2.2.1.	The Relativity of Physical Colors . . . . .	146
3.2.2.2.	Setting Standards and the Distinction Between Real and Illusory Colors . . . . .	151
3.2.2.3.	Physical Colors and Nonphysical Categories . . . . .	155
3.2.2.4.	The Causal Bases of Dispositions . . . . .	161
3.2.2.5.	Physical Colors as Mind Independent . . . . .	162
3.3.	Johnston's Argument for Dispositionalism . .	163
3.3.1.	Perceptual Availability . . . . .	164
3.3.2.	Johnston's Argument against Physicalism . . . . .	166
3.3.3.	Modified Revelation . . . . .	170
4.	Peacocke's Dispositionalism . . . . .	177
4.1.	The Relation between Color Concepts and Color Experiences . . . . .	180
4.1.1.	The Phenomenology of Color . . . . .	183
4.1.2.	Possession Conditions for Color Concepts . . . . .	186
4.2.	Physical Red and Red' . . . . .	195
4.2.1.	Red' and Noncircularity . . . . .	196
4.2.2.	Physical Red and Knowing What It's Like . . . . .	199
4.2.2.1.	Physical Red and Visual Experience . . . . .	200

4.2.2.2.	The Inverted Spectrum . . . . .	203
4.2.2.2.1.	Peacocke's Argument . . . . .	204
4.2.2.2.2.	Pseudonormal Vision . . . . .	207
4.2.2.2.3.	Individual Differences in What's Seen as Unique Green . . . . .	212
5.	Thompson's Comparative Argument . . . . .	225
5.1.	The Comparative Argument . . . . .	228
5.1.1.	Comparative Studies and Nondisjunctive Physicalism . . . . .	231
5.1.1.1.	Hilbert's Description of the Biological Function of Color Vision . . . . .	231
5.1.1.2.	Thompson's Alternative Description of the Biological Function of Color Vision . . . . .	240
5.1.2.	Comparative Studies and Varieties of Psychological Color Space . . . . .	250
5.1.3.	The Ecological Explanation of Color Categories . . . . .	257
5.2.	The Disjunctive Physicalist's Response to the Comparative Argument . . . . .	261
5.3.	Visual Experience and Perceptible Qualities . . . . .	264
Conclusion	. . . . .	269
Bibliography	. . . . .	274

## Introduction

In his classic book, Perception (1977), Frank Jackson argues for what he calls the univocality thesis (pp. 72-76). According to the univocality thesis, the best explanation for the fact that we use the word "red" to describe both perceptual states and physical objects is that the word "red" applied these ways refers to the same property.

For, Jackson claims, if "red" doesn't have univocal reference, then this term would be radically ambiguous (p. 139); the application of "red" to perceptual states and physical objects, which are utterly different types of things, would be "a fantastic fluke" (p. 73). Many proposals about the nature of color implicitly or explicitly endorse the univocality thesis.

However, this thesis about the semantics of color terms leaves open what instantiates the univocal reference of "red," that is, hallucinations or apples or both, or neither. So this claim leaves a lot of work undone. But it also does a lot of work. In particular, given that it's implausible that perceptual states and physical objects instantiate the same color properties, the univocality thesis indicates that, given that colors are instantiated by anything, one of the following claims is true: "red" refers to a mental qualitative property but not a physical

qualitative property, or "red" refers to a physical qualitative property but not a mental qualitative property.

In what follows, I examine the following questions: Do color terms refer only to properties of mental states or only to properties of physical objects, or rather do they refer to both properties of mental states and properties of physical objects? If color terms refer to both, do they refer univocally or ambiguously?

I'll call the proposal that colors are mental qualitative properties of perceptual states subjectivism, and the proposal that colors are physical qualitative properties of physical objects physicalism. According to both subjectivism and physicalism, we use color terms to describe and classify both perceptual states and physical objects. For example, the physicalist admits we say that we have red hallucinations.

But each view holds that color terms nevertheless have univocal reference--subjectivism claims that color terms refer only to mental qualitative properties of perceptual states, and physicalism claims that color terms refer only to physical qualitative properties of physical objects.

Thus, according to subjectivism, it's not the case that "red" is applied to physical objects because physical objects instantiate the property red. Rather, we must understand "red" as it occurs in "there are red physical objects" in some other way, such that "red" refers to a

mental qualitative property. The subjectivist then must explain how this property seems to be a property of physical objects.

Jackson argues for subjectivism. He claims that "red" as it occurs in "there are red physical objects" is to be understood as referring to a property of sense data, which are mental objects, which normally belong to physical objects (1977, p. 128). A sense datum "normally belongs" to a physical object if it is caused by the physical object and its spatial properties vary as a function of the spatial properties of the physical object (1977, pp. 170-171). Because red sense data belong to physical objects, the property red seems to be a property of physical objects.

Paul A. Boghossian and J. David Velleman (1989), C. L. Hardin (1993a), and James A. McGilvray (1994) also argue for subjectivism. However, these theorists claim that "red" as it occurs in "there are red objects" is to be understood as referring to a mental qualitative property of visual experiences which is attributed to mind-independent objects in visual experiences of red (Boghossian and Velleman, 1989, pp. 96-97; Hardin, 1993a, pp. 81-82; McGilvray, 1994, pp. 225-228).

According to physicalism, "red" refers to a physical qualitative property, but not a property of mental states. In this case, "red" is not applied to mental states because mental states instantiate the property red. Rather, we must

understand "red" as it occurs in "there are red hallucinations" in some other way. For example, we might understand "red" in such a context to qualify an intentional object rather than an actual object. In this case, "red" refers to a physical property. What intentional objects are, and how the physical property referred to by "red" relates to them is indicated by a theory of intentionality.

Proponents of physicalism include G. E. M. Anscombe (1965), George Pitcher (1971), D. M. Armstrong (1968a, 1987), J. J. C. Smart (1975), David R. Hilbert (1987), and Gilbert Harman (1990, 1996a).

If either the view that "red" refers to a mental property, but not a physical property, or the view that "red" refers to a physical property, but not a mental property, is true, then the univocality thesis is true.

If "red" refers to both a property of physical objects and a property of mental states, the question of univocality is left open. But few who hold that "red" refers to both a physical property and a mental property embrace the univocality thesis. (For arguments that conclude that it is incoherent to hold the univocality thesis along with the claim that "red" refers to both a physical property and a mental property, see Roderick M. Chisholm, 1966, pp. 381-382.)

Rather, those who hold that "red" refers to both a physical and a mental property are divided on whether to

endorse or reject the following claim. The red of physical objects (which I'll call physical red) is a relational property between some physical property or other of physical objects and the red of visual experiences (which I'll call mental red).

Those who endorse this claim are proponents of dispositionalism. According to dispositionalism, physical red is a disposition of physical objects to produce a perceptual response. On the versions of dispositionalism which hold that "red" refers to both a physical and a mental property, physical red is a disposition of physical objects to produce visual experiences with mental red.

If physical red is such a disposition, then it is a relational property between some physical property or other of objects and visual experiences with mental red. A physical property can't be physical red unless instances of the property are (actually or counterfactually) related to visual experiences with mental red.

Theorists who hold that "red" refers ambiguously, and that physical red is a relational property between some physical property or other of physical objects and visual experiences with mental red include Chisholm (1957), Colin McGinn (1983), Christopher Peacocke (1984a), John McDowell (1985), and Mark Johnston (1992). (Both McGinn and Johnston have by now rejected dispositionalism.)

Finally, those who hold that "red" refers ambiguously,

but that physical red is not a relational property between some physical property or other of physical objects and mental red include David M. Rosenthal (forthcoming and 1991a).

I'll argue against both subjectivism and physicalism that color terms are ambiguous between two distinct ranges of colors, the range of mental colors and the range of physical colors. Furthermore, I'll argue against dispositionalism that physical colors are not relational properties between physical properties of physical objects and mental colors.

The main tasks I'll undertake are, first, motivating the claim that there are two distinct ranges of colors, and, second, characterizing the relation between mental colors and physical colors in a way that indicates why it's not a "fantastic fluke" that we use the same color terms to describe both perceptual states and physical objects.

A pair of claims, which are commonly accepted as starting points, provide much of the motivation for the proposals about the nature of color which I reject. The first claim is that a description of colors according to our ordinary experience of color provides a specification of at least some aspects of the nature of color.

In ordinary experience, we're aware of the qualitative identities, differences, and similarities among the colors we perceive objects as having. For example, we're aware

that orange is qualitatively more similar to red than it is to blue.

According to this first claim, a description of the qualitative similarity relations that we're aware of in ordinary experience provides a specification of an aspect of the nature of color. Thus, a property can't be orange unless it is more similar to red than blue.

This claim is used to impose a constraint on the properties that can be identified with colors. It holds that no range of properties can be identified with colors unless members of the range of properties are intrinsically related in ways that correspond with the qualitative similarity relations among colors which we're aware of in ordinary experience. (Members of a range of properties are related intrinsically in these ways so long as they're related in these ways not by virtue of relations between members of the range and members of a distinct range of properties.)

However, this claim doesn't impose any constraints on how we come to know that members of a range of properties are intrinsically related in ways that correspond with the qualitative similarity relations that we're aware of in ordinary experience. We might come to know this through scientific investigation. I'll call this first claim the metaphysical constraint on the nature of color.

The second claim is a related epistemological claim:

our ordinary experience of color provides access to the nature of colors. According to this claim, our awareness of the qualitative similarity relations in ordinary experience provides us with access to at least some aspects of the nature of color.

This epistemological claim also holds that a description of the qualitative similarity relations we're aware of in ordinary experience provides a specification of the nature of color. In addition, this claim imposes a strong constraint on how we come to know that members of a range of properties are intrinsically related in ways that correspond with the qualitative similarity relations. We must come to know this in ordinary experience. I'll call this claim the epistemological constraint on the nature of color.

As I'll show, it is primarily acceptance of either the metaphysical or the epistemological constraint on the nature of color which leads theorists to embrace subjectivism or dispositionalism. I shall argue that providing a satisfying account of the nature of color requires rejecting both of these constraints.

Since these constraints are commonly accepted as starting points, few arguments are offered in support of them. I'll consider the arguments that are offered, in particular those of Johnston and Peacocke provided in support of the epistemological constraint, and lay out why

these arguments aren't successful.

I'll also argue that because subjectivism holds that the colors we attribute to mind-independent objects in visual experience are mental colors, this view cannot provide a plausible account of color perception. This deep problem with explaining color perception provides a strong reason to reject subjectivism, as well as a version of the epistemological constraint on which Boghossian and Velleman's subjectivism is founded.

I shall offer an alternative proposal about the nature of color. I'll argue that although descriptions of colors according to our ordinary experience of color provide conceptual constraints on identifying a range of properties with colors, such descriptions don't specify the nature of color at all. Rather, descriptions of colors according to our ordinary experience merely serve to fix the reference of color terms.

Such reference-fixing descriptions are descriptions of causal relations among colored physical objects, visual experiences of colors, and other mental states such as beliefs about colored physical objects, and beliefs about visual experiences of colors. Furthermore, we fix the reference of terms for two ranges of colors, mental colors and physical colors, by descriptions of causal relations among colored physical objects and mental states.

Although terms for both mental color and physical

colors are interdefined, there's no problem with circularity, because both mental and physical color terms can have their references fixed by paradigmatic exemplars. We can fix the reference of physical red by a strawberry, or a fire engine, or a British mail box. What's picked out is a property of these physical objects. We can fix the reference of mental red by the same exemplars, but what's picked out is a property of visual experience in virtue of which we perceive the color of the paradigmatic exemplars.

I'll argue that reference-fixing descriptions of causal relations among colored physical objects and mental states pick out nonrelational physical properties of physical objects as the referents of physical color terms. Such descriptions pick out nonrelational properties of neural processes as the referents of mental color terms.

In this case, pairs of mental colors and physical colors, such as mental red and physical red, are systematically related due to systematic causal relations among members of the range of mental colors and members of the range of physical colors. Due to these systematic causal relations, it's not a "fantastic fluke" that we use the same color terms to describe both perceptual states and physical objects.

I shall start by characterizing visual experiences, focusing primarily on describing mental colors.

## 1. Visual Experience and Sensory Qualities

Boghossian and Velleman approach the issue of the nature of color by way of the following question: what is the nature of the colors that we attribute to physical objects in virtue of our visual experiences of physical objects? Are these properties monadic physical properties of objects, mental qualitative properties of visual experiences, or relations between physical properties of objects and mental qualitative properties (1991, p. 68)?

They answer that the colors we attribute to physical objects in visual experience are mental qualitative properties of visual experience itself. To introduce Boghossian and Velleman's view, I shall introduce their notion of visual experience.

According to Boghossian and Velleman, visual experience is the sort of perceptual state involved in seeing. Visual experience is a relation of a perceiver to a visual field (1989, p. 94). As the term "experience" suggests, visual experiences are conscious states. Thus, visual fields are arrays of mental properties of which we are directly conscious.<sup>1</sup>

---

<sup>1</sup> In his very helpful article "Three Varieties of Visual Field" (1996b), Austen Clark distinguishes Boghossian and Velleman's notion of visual field from other notions. What Boghossian and Velleman have in mind is, as Clark puts

Visual experiences have both qualitative and representational properties (1989, p. 96). The qualitative properties of visual experiences are nonrelational mental properties of their visual fields (1989, p. 92). I'll refer to the qualitative properties of experiences as sensory qualities and the colors of visual experiences as mental colors.

The representational properties of visual experiences are relations of the qualitative properties of their visual fields to (actual or nonactual) physical objects and properties (1989, p. 82, fn. 4, p. 93). (See Peacocke, 1983, p. 5, for a similar notion of visual experience.)

Visual experiences, being mental states with representational properties, have representational contents. Boghossian and Velleman assume that the content of the visual experience reported "I see that the apple is red" is that a particular apple is red (1989, p. 82, fn. 4). Thus, they indicate that the contents of experience are propositions referred to by 'that' clauses.

However, they are not concerned with either proposing or defending a theory of the content of experience. Such an undertaking would require considering questions such as the following: how do we specify the propositions referred to

---

it, an array of impressions, or mental properties, of which we are directly aware. I'll use the expression "visual field" only in this sense.

by 'that' clauses embedded in reports of perceptual experiences? How does the specification of the contents of experience differ from that of the contents of belief? (See Crane, 1992b, pp. 6-12 for an introduction to these questions.)

Rather, Boghossian and Velleman are concerned with a much more limited question: is the property red attributed by the visual experience reported "I see that the apple is red" a monadic property of a physical object, a mental color, or a relation of a property of a physical object to a mental color?

Next, I'll distinguish Boghossian and Velleman's account of visual experience from sense datum accounts, and thus show that criticisms of sense datum accounts are not problems for Boghossian and Velleman's characterization of visual experience. Then I'll consider the representational and qualitative properties of visual experience more closely.

My discussion of sensory qualities will take Boghossian and Velleman's brief description as a starting point for a more detailed examination. In chapter 2, I shall evaluate Boghossian and Velleman's arguments for the claim that the colors we attribute to physical objects are mental qualitative properties of visual experiences.

### 1.1. Visual Fields and Sense Data

Sydney Shoemaker (1994, p. 25) asserts that in claiming that visual experiences are relations of perceivers to visual fields, Boghossian and Velleman suggest a revival of the sense datum account of perceiving.

Sense datum theories claim that perceptual states are relations between perceivers and sense data, mental objects that have colors and shapes. (See, Jackson, 1977, for such a view.) It seems that in visual experience we are aware of colored objects. If, as Boghossian and Velleman hold, the colors we are aware of in visual experience are properties of parts of the visual field, then it seems that the visual field is comprised of colored mental objects.

Sense datum theories face difficulties in explaining how sense data, as mental objects, are related to the physical states, and in particular, neural states, of perceivers. Thus, if Boghossian and Velleman's account of the visual field commits them to holding that visual fields are sense data, then they face the same difficulties.

However, Boghossian and Velleman hold that their view is consistent with an adverbialist theory of perceiving (1989, p. 96). By contrast with sense datum theories, adverbialist theories claim that a perceptual state is a relation between a perceiver and (actual or nonactual) physical objects and properties rather than sense data, and that perceptual states themselves are modified by mental

properties such as mental colors. (See, for example, Chisholm, 1966, p. 382 for such a view.)

Boghossian and Velleman claim that visual fields ". . . may or may not be describable by means of adverbs modifying mental verbs rather than by substantives denoting mental items" (1989, p. 96). Visual fields may supervene on neural events, states, or processes (1989, p. 96). In this case, we can understand visual experience as a relation between a perceiver and (actual or nonactual) physical objects and properties. Thus, unlike sense datum accounts, Boghossian and Velleman's account raises no difficulties for mind-body materialism.

Thus, even though Boghossian and Velleman hold that in visual experience we are aware of properties, and in particular colors, of visual fields, they are not thereby committed to holding that visual fields are comprised of mental objects. Although it seems that colors are properties of objects, Boghossian and Velleman hold that colors are properties of visual fields, which may be described as mental events, state, or processes.

Rather, visual experiences are relations of perceivers to visual fields, and visual fields play an intermediary role in perceiving physical objects. In visual experience, mental colors are erroneously attributed to physical objects, and thus aren't properties of objects at all (1989, p. 96).

The claim that the colors we are aware of in visual experience are properties of mental events, states, or processes which are attributed to physical objects raises serious objections. I'll consider these in chapter 2. However, since Boghossian and Velleman's account of colors as properties of parts of the visual field is consistent with an adverbial account, it isn't vulnerable to criticisms that have been directed at sense datum accounts.

### 1.2. The Representational Properties of Visual Experience

The issue of how to characterize the representation of color by visual experience is determined by answering Boghossian and Velleman's primary question. What is the nature of the colors that we attribute to physical objects in visual experiences? Are these properties monadic physical properties of objects, sensory qualities, or relations of physical properties of objects to sensory qualities?

If the colors attributed to physical objects are monadic physical properties of objects, then the representational properties of visual experience of color are characterized as causal relations of properties of visual experiences to (actual or nonactual) physical objects and properties, including physical colors (1989, pp. 82-83; 1991, p. 75).

For example, the representational properties of visual

experience may be characterized as informational properties of visual experiences. Informational properties are, very generally, causal relations between properties, where the occurrence of one property is highly probable given the occurrence of the other property, and is not highly probable otherwise (Clark, 1993, pp. 50-52). (See Fred I. Dretske, 1980, pp. 285-287, and Peacocke, 1983, pp. 6-7 for different but related notions of informational properties.)

If the colors attributed to physical objects are dispositions of physical properties of objects to produce visual experiences with mental colors, then physical colors are not merely causally related to properties of visual experiences. Physical colors are relations of physical properties of objects to mental colors, and thus are in part constituted by mental colors. Still, we may characterize the representational properties of visual experiences of color as causal relations of properties of visual experiences to (actual or nonactual) physical objects and properties, including physical colors.

Boghossian and Velleman claim that some dispositionalists propose a circular account of visual experience of color because they hold that physical colors are in part constituted by properties of visual experiences and they characterize the representational properties of visual experiences of color in terms of physical colors (1989, pp. 83-86). I'll consider their claim in chapter 2.

Finally, Boghossian and Velleman claim that if the colors attributed to physical objects are sensory qualities, then visual experience of the colors of physical objects involves projective representation. Projective representation of color is the attribution of mental colors to physical objects. Since mental colors are not properties of physical objects, our visual experiences of color are systematically erroneous (1989, p. 96).

In this case, the representation of physical objects as colored isn't a causal relation at all. Even though mental colors are caused by physical properties of physical objects, these physical properties of objects are not represented in visual experience.

Rather, the representation of physical objects as colored is the locating of mental colors in physical space, such as on the surfaces of physical objects. This locating relation isn't a causal relation. (McGilvray provides an alternative account of projective representation of color. I'll consider this alternative in chapter 2.)

Boghossian and Velleman argue that the correct account of the representational properties of visual experience is the projective account. They argue that the other accounts of the representational properties of visual experience are objectionable on either epistemological or phenomenological grounds.

In chapter 2, I shall consider Boghossian and

Velleman's arguments for projective representation of color, and consider whether a plausible account of projective representation of color can be given. In the remainder of this chapter, I'll examine sensory qualities.

### 1.3. The Qualitative Properties of Visual Experience

Boghossian and Velleman claim that visual fields have what they call intrinsic mental properties (1989, pp. 92-94). They describe intrinsic mental properties of visual fields, by contrast with representational properties, as not being relations of properties of visual fields to (actual or nonactual) physical objects and properties (1989, p. 92). Mental properties of visual experience which aren't relations in this sense are what I call sensory qualities.

Boghossian and Velleman provide little further description of sensory qualities, aside from noting that the visual fields that instantiate sensory qualities may supervene on neural events, states, or processes (1989, p. 96). Before considering their argument for holding that visual experiences have sensory qualities, I shall provide some further description of sensory qualities.

#### 1.3.1. Describing Mental Color

I'll examine mental colors as a species of sensory qualities. I'll start with a description that I take to be uncontroversial, at least among those who accept mental colors at all. Mental colors are the mental qualitative

properties of perceptual states in virtue of which we perceive the colors we attribute to physical objects. Any attempt to make this description less vague requires entering into a deep controversy about the nature of sensory qualities.

In the current philosophical literature there are two common approaches to the problem of describing mental colors. According to one approach, mental colors are what it is like for a perceiver to be conscious of colors, and thus must be described in terms of our consciousness of colors (this approach is taken by Thomas Nagel [1974], Joseph Levine [1983], Jackson [1986], Ned Block [1990], and Shoemaker [1990]).

On the other approach, mental colors are properties of visual experience which can be described in terms of causal relations among properties of visual experiences and other mental properties, such as properties of beliefs about visual experiences, and nonmental properties such as the colors of objects (this approach is taken by David Lewis [1980, 1988, 1995, and forthcoming], and Clark [1993]).

Proponents of the claim that mental colors are what it's like for a perceiver to be conscious of colors hold that mental colors cannot be described in terms of causal relations among properties of visual experiences and mental or nonmental properties. These theorists hold that what it's like to be conscious of color is a property of visual

experience that cannot be described in terms of causal relations at all. (See, for example, Levine, 1983, pp. 356-361, and Block, 1990, pp. 54-55 for these claims.) In this case, mental colors are nonrelational mental properties in a very strong sense.

Following the terminology standard in the literature, I'll use the term "qualia" for the notion of mental colors according to which mental colors are what it's like to experience colors. (There is a less common use of the term "qualia," according to which they are physical properties of physical objects which are represented in visual experience of color. See, for example, Dretske, 1995, p. 65.)

Holding that mental colors are what it's like to be conscious of colors is tantamount to holding that mental colors are necessarily conscious. For the possibility of unconscious instances of mental colors isn't compatible with the proposal that mental colors just are what it's like to be conscious of colors. In this case, mental colors must be described in terms of our consciousness of colors.

The proponents of describing mental colors in terms of causal relations among properties of visual experience of color and mental or nonmental properties deny that mental colors must be described in terms of our consciousness of colors. To the contrary, they propose to describe mental colors in terms of causal relations in order to identify mental colors with physical properties of perceivers, for

example, neural properties. In this case, mental colors can be described in neural terms and thus needn't be described in terms of our consciousness of colors.

This dispute about the nature of mental colors has consequences for a proposal about the nature of physical color. According to the view that mental colors are color qualia, physical properties of objects are irrelevant in determining what it's like to experience physical objects as colored. Rather, qualia alone determine what it's like to experience physical objects as colored. (Color qualia are described as what it's like to be conscious of color. For those who hold that visual experiences have color qualia and that in visual experience of colored physical objects, the color we are aware of is a physical property of objects, color qualia are said to determine what it's like to be conscious of physical objects as colored [Shoemaker, 1996, p. 64].)

Assuming that physical colors are properties of physical objects which we experience as colors, if mental colors are color qualia then physical colors cannot be monadic physical properties of physical objects. Rather, physical colors are relations between physical properties of objects and color qualia, qualitative mental properties which alone determine what it's like to experience physical objects as colored. (Shoemaker holds both that visual experiences have qualia and that physical colors are monadic

physical properties of objects. However, Shoemaker holds that the properties of physical objects which we experience as colors aren't physical colors, but rather relations between physical properties of physical objects and visual experiences with color qualia. Rather, physical colors are the physical bases of these relations [Shoemaker, 1996, pp. 58-66].)

Because I defend the view that physical colors are monadic physical properties of physical objects, I am motivated to deny that mental colors are color qualia. Thus, I am motivated to argue that mental colors are describable in terms of relations among properties of visual experiences and mental and nonmental properties.

Although I cannot provide a conclusive argument for the claim that mental colors can be described in causal terms, and thus needn't be described in terms of our consciousness of colors, I believe there are good reasons to hold that this claim is correct. As Rosenthal (1991a) claims, the pivotal question is whether mental colors are necessarily conscious properties. I shall give a general motivation for denying that mental colors are necessarily conscious.

### 1.3.2. Explaining Mental Color

In his important article "Materialism and Qualia: the Explanatory Gap" (1983), Levine claims that we cannot explain mental colors in terms of neural or functional

properties of visual experiences. He argues for this claim by holding that what it's like to be conscious of color can't be explained in terms of neural or functional properties. Levine asserts that what it's like to be conscious of color cannot be related to neural or functional properties in an intelligible way (p. 358).

What would constitute an intelligible relation between what it's like to be conscious of color and neural or functional properties? Levine proposes the following constraint for explanatory identifications of commonsense properties with theoretical properties, such as the identification of heat with the motion of molecules. Such an identification is explanatory if the commonsense property can be fully described in terms of its causal relations, and the theoretical property fully explains the causal relations of the commonsense property.

So, for example, the identification of heat with the motion of molecules is explanatory because the property of heat can be fully described in terms of its causal relations. Furthermore, the motion of molecules explains the causal relations of the property heat. The motion of molecules explains effects of heat, such as the expansion and contraction of heated and cooled metals (Levine, 1982, p. 357, pp. 358-359).

On the basis of this constraint, Levine asserts that the identification of mental color with the neural or

functional properties of visual experiences is not explanatory. He allows that visual experiences of color are involved in causal relations, and the identification of visual experiences with neural states explains these causal relations. For example, this identification explains how visual experiences of color are caused by physical properties of colored physical objects (p. 357).

But it seems that there is no description of what it's like to be conscious of color in terms of the causal role of visual experiences. Thus, the neural or functional properties of visual experience of color, which explain the causal role of these mental states, don't explain what it is like to be conscious of color (pp. 357-358).

In Sensory Qualities (1993), Clark forcefully argues that, to the contrary, we can explain mental colors in neural and functional terms.

Clark first proposes a method of describing mental colors in terms of qualitative similarity relations that correspond to the qualitative similarity relations among perceived colors (where perceived colors just are the colors we perceive physical objects as having) (1993, pp. 76-116). By working out qualitative similarity relations among perceived colors, one can construct what's called the psychological colors space.

The psychological color space is a three dimensional representation of the qualitative similarity relations among

colors. The three dimensions of the psychological color space are hue, lightness, and saturation. Hue is the chromatic dimension; lightness is the achromatic, or white to black, dimension; and saturation is the dimension that maps a color's proportion of chromatic to achromatic content. Saturated colors have a high proportion of chromatic content (Clark, 1993, pp. 119-124).

The psychological color space can be constructed by way of a sophisticated psychophysical technique called multidimensional scaling. (Psychophysics is the study of the relation of the properties of physical stimuli to the sensory experience of a perceiver.)

Multidimensional scaling involves measuring relative similarities among stimuli with respect to some range of qualities to generate a spatial representation of the similarity relations among the members of the range (Clark, 1993, ch. 4, appendix). The psychological color space is just such a spatial representation of the qualitative similarity relations among colors.

Having constructed the psychological color space, particular mental colors can be defined in terms of the relations of a location in the color space to other locations. For example, a particular shade of red is defined in terms of its relations to other shades of red as well as other colors such as orange and green.

Particular mental colors are then identified with

functionally-described properties of processes of the visual system which explain the qualitative similarity relations among perceived colors (Clark, 1993, p. 148). Thus, I'll give a brief general description of the explanation of qualitative similarity relations in terms of processes of the visual system.

Visual experiences of specific hues are associated with specific ratios of stimulation of three types of wavelength-sensitive retinal cells called cones (Clark, 1993, p. 44). Each cone type is particularly sensitive to wavelengths in a region of the spectrum, specified as the longwave, middlewave, and shortwave regions. These cones are called the L cones, M cones, and S cones, respectively.

According to the opponent process theory of color vision, such ratios of activation of the three types of cones are then encoded in other processes of the human visual system, namely, two opponent chromatic channels (red-green and yellow-blue channels), and one opponent nonchromatic channel (black-white). The chromatic channels are processes that encode ratios of activation of the three types of cones by gauging differences in the activations of the cone types. For example, the red-green channel gauges the difference in the activation of the M cones from that of the L cones. The nonchromatic channel gauges sums of the activations of the L and M cones.

Thus particular mental colors, for example, mental red,

are identified with properties of the opponent processes which encode specific ratios of activation of the three types of cones. If the red-green channel gauges that the activation of the L cones is greater than that of the M cones, then this channel is excited. Excitation of the red-green channel encodes red.

If the red-green channel gauges that the activation of the L cones is less than that of the M cones, the channel is inhibited. Inhibition of the red-green channel encodes green (Clark, 1993, pp. 149-153). (The neural processes that realize the channels haven't yet been discovered. Because of this, it's merely a convention to indicate that excitation rather than inhibition of the red-green channel encodes red [Hardin, 1993a, p. 35; Davida Y. Teller, 1991, pp. 52-53].)

Whether a physical object is seen as red also depends on the excitation of the yellow-blue channel. The yellow-blue channel gauges the difference in the activation of the S cones from that of the sum of the M and L cones. If the yellow-blue channel gauges that the activation of S cones is less than the activations of the M and L cones combined, the channel is excited. Excitation of the yellow-blue channel encodes yellow (Clark, 1993, pp. 149-153).

If the object excites the red-green channel as well as the yellow-blue channel, the object is seen as a mixture of red and yellow, namely, orange. If the object excites the

red-green channel, but neither excites nor inhibits the yellow-blue channel, it is seen as red.

Furthermore, qualitative similarity relations are explained by the opponent channels. Thus, for example, that orange is more like red than blue can be explained by the chromatic channels as follows. The encoding of orange involves the encoding of red by the red-green channel and the encoding of yellow by the yellow-blue channel.

Since yellow is the opponent of blue, in standard viewing conditions, the visual system doesn't encode yellowish blues. (But it may be that the visual system can encode yellowish blues in nonstandard viewing conditions. See Hewitt D. Crane and Thomas P. Piantanida, 1983, according to whom the yellow-blue channel can be bypassed due to nonstandard viewing conditions, and there is encoding of yellowish blue.) Thus, since the encoding of orange involves the encoding of yellow, orange cannot be bluish. And since the encoding of orange involves the encoding of red, orange is reddish (Clark, 1993, p. 151).

My description of the opponent processes has been in the functional specifications provided by psychophysics. The opponencies of red and green, for example, are specified by psychophysical findings. Although opponent neural mechanisms have been discovered in the visual system, the neural processes that realize the opponent channels haven't been found (Hardin, 1993a, pp. 12-19, p. 35; Teller, 1991,

pp. 52-53).

Nevertheless, the explanation of the qualitative similarity relations among colors by opponent processes is accepted by many visual scientists, for example, see Leo M. Hurvich (1981, pp. 128-135), Robert M. Boynton (1979, pp. 207-250), and Peter Gouras (1985, pp. 388-394). (But some visual scientists, without rejecting this explanation, have reservations. See, for example, Teller [1991, pp. 51-58].)

I'll assume that the opponent process theory is fundamentally correct, and that there are neural processes that realize the opponent channels. Thus, a particular mental color, for example, mental red, is identified with a property of the neural processes that realize opponent channels as specified by the opponent process theory (Clark, 1993, pp 146-164).

In this case, the identification of mental colors with neural properties is explanatory. Mental colors are defined in terms qualitative similarity relations, and neural properties explain the qualitative similarity relations.

However, if mental colors are qualia, then the purported explanation of mental colors in terms of neural processes fail. For descriptions of mental colors in terms of qualitative similarity relations fail to articulate what it's like to be conscious of colors. What it's like to be conscious of colors isn't describable in terms of any relations at all.

The underlying assumption is that we must describe mental colors in terms of consciousness of colors, and thus that mental colors are necessarily conscious (Rosenthal, 1991a). (See also Evan Thompson, 1992, pp. 341-342, who points out this underlying assumption.) If we hold that mental colors are qualia, and thus are necessarily conscious, it seems that there can be no explanation of mental colors in nonmental terms at all. However, if mental colors aren't necessarily conscious, then there's no reason to believe that we can't describe mental colors in terms of causal relations, and explain them in terms of properties of neural processes (Rosenthal, 1991a, pp. 16-22).

Rather than reject the purported explanations of mental colors in terms of properties of neural processes, these explanations provide us with a general motivation for rejecting the claim that mental colors are necessarily conscious. Thus, these explanations give us a general motivation for denying that mental colors are qualia, and accepting that mental colors are properties of visual experiences described in terms of their causal relations, explained in neural terms, and identified with properties of neural processes (Clark, 1993, pp. 11-12).

However, Jackson (1982) argues that considerations about knowing what it's like to experience red show that mental colors can't be identified with neural properties. He claims that knowing what it's like to experience red is

knowledge that visual experiences of red are a certain way, and that this way that they are can't be described or explained in nonmental terms. We might know all there is to know about visual experiences of red in physical or neural terms and still not know what it is like to experience red. Rather, knowing what it's like to experience red is knowledge that visual experiences of red are a certain way that can only be described in terms of our consciousness of red.

Laurence Nemirow (1990, pp. 492-493) and Lewis (1983, p. 234, 1988, pp. 514-518) provide a characterization of what it's like to be conscious of color according to which knowing what it's like can be described in terms of causal relations among properties of visual experiences and other mental and nonmental properties.

They argue that knowing what it's like to experience red isn't knowledge that visual experiences of red are a certain way that can only be described in terms of our consciousness of red. Rather, it is knowledge of how to bring about the performance of aspects of the causal roles of visual experiences of physical red and of introspective states of experiences of red--in particular, aspects of the causal roles of such states in virtue of which they are classified as experiences of red and introspective states of experiences of red. It is knowledge of how to, for example, recognize red as a property of physical objects, and imagine

red.

This claim about knowing what it's like to experience red is called the ability hypothesis (Lewis, 1988, pp. 514-515). If the ability hypothesis is correct, then considerations about knowing what it's like for a perceiver to experience red do not show that mental red cannot be described in terms of causal relations. (Others, for example, Terence Horgan, 1984a, and Brian Loar, 1990, provide different arguments against Jackson's knowledge argument.)

There are many other arguments, aside from Levine's and Jackson's, used to motivate the claim that mental colors are qualia. In chapter 4, I shall consider another group of such arguments, those based on considerations about the possibility of a so-called inverted spectrum, in the context of examining arguments for a dispositionalist proposal about the nature of physical color.

I shall, for the present discussion, rest with the general motivation, as stated by Clark, that psychological research appears to have provided an explanation of mental colors in terms of neural processes of the visual system. If this empirical research does give an explanation of mental color, then we have reason to deny that mental colors are qualia, namely, mental qualitative properties that are necessarily conscious.

### 1.3.3. The Nature of Mental Color

I've argued that mental colors can be described in terms of causal relations among properties of visual experiences and other mental and nonmental properties. In this section, I shall consider whether mental color is constituted by relations among mental properties, in particular, by the properties of neural processes which explain the qualitative similarity relations among colors.

Block distinguishes two kinds of functional role according to which we can specify the nature of mental colors, namely, long-arm functional role and short-arm functional role (1990, p. 58). Generally speaking, a functional role specification of the nature of mental color holds that mental colors are constituted by certain causal relations among properties of visual experiences and mental or nonmental properties.

If we hold that the nature of mental color is specified by long-arm functional roles, then mental colors are relations among properties of visual experiences, their physical causes, and their mental and behavioral effects. In this case, since mental colors are (in part) constituted by a relation between a property of visual experience and the colors of physical objects as physical causes, mental colors are representational properties of visual experiences (Block, 1990, p. 58).

By contrast, if we hold that the nature of mental color

is specified by short-arm functional roles, then mental colors are relations among internal mental properties of perceivers, where internal mental properties "stop at the skin" (Block, 1990, p. 58). Thus, mental colors are not relations among properties of visual experiences and properties external to the perceiver, such as their physical causes and behavioral effects (Block, 1990, p. 58, p. 70).

The important distinction between these two kinds of functional role characterization is that according to the short-arm proposal, a specification of the nature of mental color doesn't involve physical color at all. This proposal doesn't deny that we can describe mental colors in terms of causal relations between properties of visual experiences of color and physical properties physical objects. However, it denies that mental colors are (in part) constituted by relations between properties of visual experiences and physical properties of physical objects.

#### 1.3.3.1. Clark's Proposal

As I've characterized mental colors, they are properties distinct from the representational properties of visual experience. Thus, they aren't specified by long-arm functional roles. In this section, I'll consider whether the nature of mental colors should be specified by short-arm functional roles.

Clark proposes a short-arm functional role

specification of mental color (1993, p. 202). He defines mental colors in terms of their qualitative similarity relations, and identifies mental colors with the relations among properties of neural processes which explain the qualitative similarity relations.

Clark describes mental colors in terms of the causal relations between properties of visual experiences of color and the colors we perceive physical objects to have. Furthermore, he describes the qualitative similarity relations among mental colors as corresponding with the qualitative similarity relations among perceived colors. Thus, he holds that we come to know the qualitative similarity relations among mental colors by way of our awareness of qualitative similarity relations among perceived colors (1993, pp. 184-188).

However, according to Clark, mental colors are defined in terms of qualitative similarity relations that correspond with the qualitative similarity relations among perceived colors. He holds that qualitative similarity relations specify the nature of mental colors. Thus, he endorses what I call the metaphysical constraint on the nature of color, according to which a description of the colors according to our ordinary experience of color specifies at least an aspect of the nature of color.

He proposes, for example, that "mental orange" is defined as a quale that is about as similar to mental red as

it is to mental yellow (1993, p. 184, p. 188, p. 200, p. 203). Furthermore, he claims that it is impossible that mental orange ". . . becomes a unique hue, so that one can pick out a pure orange--an orange hue that is not at all reddish and not at all yellowish" (p. 203).

It is also impossible that mental orange resemble mental blue more than mental red (p. 203). A property of visual experience is mental orange only if it is a binary hue that resembles red more than it does blue. These definitions specify the nature of mental colors in terms of qualitative similarity relations. Mental colors are whatever properties of neural processes that explain these relations.

As Clark shows, the qualitative similarity relations among colors are explained in terms of functionally-described processes of our visual systems. We can explain the psychological color space in terms of opponent processes. For example, the location of orange between red and yellow in the color space is explained by the fact that the encoding of orange involves the encoding of red by the red-green channel and the encoding of yellow by the yellow-blue channel (1993, pp. 147-151).

Since Clark holds that qualitative similarity relations specify the nature of mental colors, he holds that this nature is specified in terms of short-arm relations, that is, relations among internal mental properties of

perceivers, which explain the qualitative similarity relations (1993, pp. 199-202). Thus, Clark holds that mental colors are constituted by causal relations among properties of neural processes that realize the opponent channels that explain the qualitative similarity relations among colors.

I shall argue, to the contrary, that although the qualitative similarity relations among colors set conceptual constraints on identifications of properties with mental colors, the relations don't specify the nature of mental colors. Rather, descriptions of mental colors in terms of qualitative similarity relations among perceived colors merely serve to fix the reference of mental color terms.

Our ordinary experience of the colors of physical objects which informs our categorizations of colors by qualitative similarity relations. By holding that descriptions of mental colors in terms of the qualitative similarity relations among perceived colors merely serve to fix the reference of mental color terms, we can draw the right distinction between our description of mental color according to our ordinary experience of color and the neurophysiological nature of mental color.

#### 1.3.3.2. The Lewisian Alternative

In his classic article, "Mad Pain and Martian Pain" (1980a), Lewis motivates drawing a distinction between the

descriptions by which we pick out properties of mental states according to our ordinary experience and characterizations of the natures of the properties picked out.

Such descriptions, which include descriptions of causal roles, set conceptual constraints. Pains, for example, can be described as mental states causally related to bodily damage and behavior such as attention to bodily damage. Mental states that don't fit a description along these lines don't meet conceptual constraints on when a mental state is a pain state (1980a, pp. 230-231).

The nature of pain is the state picked out by the description of the causal role of pain. The description of the causal role of pain serves to pick out a particular neural state in normal human beings. This neural state is pain in normal human beings (1980a, pp. 230-231).

Having drawn the distinction between the description of the causal role of pain and the nature of pain, we can use the distinction to address the following possible case. It's possible that there is a person who is abnormal in the following way: the neural state that is pain in normal human beings doesn't fit the description of the causal role of pain.

In this case, we can say that the abnormal person is in pain because he is in the neural state that occupies the causal role of pain in normal human beings. We can say this

because we can distinguish between the conceptual constraints on when a mental state is a pain state, and the neurophysiological nature of pain (1980a, pp. 231-232). (See also Lewis, 1995; Lewis, forthcoming, pp. 2-3 for more discussion of this view.)

Lewis also applies the distinction to mental colors. He characterizes a person whose mental colors, described as neural properties, are inverted in comparison with the neural properties of normal people. This person's visual system is such that when he sees green physical objects and sees the physical object as being green, his experience has a property which, described as a neural property of his visual system, is the same as that produced in normal people by red physical objects. But described in terms of the color he perceives and his beliefs about the qualitative similarity relations among perceived colors, the property of his visual experience produced by green physical objects is mental green (1980a, p. 232).

According to Clark, it would be a conceptual error to claim that the inverted perceiver's visual experience of green physical objects has mental red. But from the standpoint of the normal perceiver's neurophysiology, we can say that the inverted perceiver's visual experience of green physical objects has the property mental red. We must rule out the latter description only if we take the qualitative similarity relations we're aware of in ordinary experience

to specify the nature of mental colors.

In discussing the possibility of inverted mental colors, Clark states,

[o]ne would need to imagine that the same qualitative state could come to serve different proximal roles [described in terms of qualitative similarity relations], or that different qualitative states could be found to have identical proximal roles. . . . One would need to imagine that orange--that very same quale--would no longer resemble its current neighbors. Orange--not the experience caused by looking at oranges, but orange itself--must cease to be somewhat reddish and somewhat yellowish (p. 202).

Having defined mental colors in terms of qualitative similarity relations, it's impossible for mental colors to be inverted. "Orange itself" is the specification of the nature of mental orange in terms of qualitative similarity relations.

However, if mental colors have neurophysiological natures, it is possible for mental colors to be inverted, as Lewis describes. Holding otherwise simply conflates our description of colors according to our ordinary experience of color with a specification of the nature of mental color.

An account of the nature of mental color may pick out mental colors in terms of qualitative similarity relations. However, these relations shouldn't be taken as specifications of natures. Qualitative similarity relations among perceived colors are indicative of the natures of mental colors, for these relations are determined by these natures. However, the nature of mental color is

neurophysiological.

Furthermore, by drawing a distinction between a description of colors according to our ordinary experience and a specification of the nature of mental color, we can allow that the qualitative similarity relations are contingent. To illustrate the contingency of these relations, Crane and Piantanida (1983) describe an experiment that indicates that it may be that the visual system can encode yellowish blues in nonstandard viewing conditions.

I propose that mental colors are nonrelational neural properties of the human visual system which are picked out according to a description of the causal relations of visual experiences of color. For example, mental red is a nonrelational neural property picked out by a description of the causal relations among red physical objects, visual experiences of red, and other mental states such as beliefs about red physical objects, and beliefs about visual experiences of red.

Such a description includes qualitative similarity relations among mental colors. For the qualitative similarity relations among mental colors are described as corresponding with the qualitative similarity relations among perceived colors.

Also, such a description includes some physical object or other which paradigmatically exemplifies a color. For

example, "mental red" is fixed by the description "the color property of visual experience caused by a property of ripe strawberries". (Clark also claims that mental color terms have their references fixed by paradigmatic exemplars [1993, pp. 184-188]. Nevertheless, he takes descriptions of the qualitative similarity relations among perceived colors to provide specifications of the nature of mental colors [1993, p. 188].)

Thus, descriptions that fix the reference of mental color terms include paradigmatic exemplars of colors along with descriptions of qualitative similarity relations among perceived colors. Although we pick out mental colors in terms of descriptions of our ordinary experience of the colors of objects, and thus of the qualitative similarity relations among them, these descriptions don't provide us with a specification of the nature of mental colors.

#### 1.3.4. Motivations for Mental Color

So far, I've given an account of what mental colors are, if there are such properties. Now I shall consider what reasons we have to hold that visual experiences have mental colors.

It's uncontroversial that our visual systems have neural processes that encode colors. The resistance to the claim that visual experiences have mental colors takes the form: why believe that properties of these neural processes

are colors?

I'll consider two sorts of arguments for the claim that there are mental colors. The first sort provides reasons to hold that, at least sometimes, the colors we are aware of are mental colors. This sort of argument usually takes the following form. We must accept that there are mental colors because there are cases, for example, cases of afterimages and hallucination, where we can't account for the colors we're aware of in terms of physical properties of physical objects.

The other sort of argument holds that certain properties of neural processes can be called colors due to the important role that they play in determining color categories, that is, the categories by which we classify colors as qualitatively the same or different, or as qualitatively similar or dissimilar. This sort of argument is supported by psychological research that shows properties of visual experience of color are important in determining our color categories.

I'll consider examples of both sorts of arguments. Since I have already given general grounds for rejecting color qualia, that is, mental colors that are necessarily conscious, I won't examine motivations for mental colors that rely on the claim that visual experiences of color have

color qualia.<sup>2</sup> (Nevertheless, either of these sorts of argument can be conjoined with the claim that visual experiences of color have color qualia. For example, some theorists hold that the colors we are aware of in perception and hallucination are color qualia [see, for example, Jackson, 1982]. Others hold that color qualia determine our color categories, even though the colors we are aware of in perception or hallucination are never qualia [see, for example, Shoemaker, 1996].)

#### 1.3.4.1. Awareness of Mental Color

Are the colors we are aware of ever mental colors? For, example, are the colors of afterimages mental colors?

The arguments for the claim that, at least sometimes, the colors we are aware of are mental colors are commonly provided as arguments against theories of perception that are often called intentionalist theories. According to such theories of perception, the only qualitative properties we are aware of in perceptual or introspective states are physical qualitative properties of physical objects, and the only qualitative properties included in the representational contents of such states are physical qualitative properties. (See Harman, 1990; Michael Tye, 1994; Dretske, 1995, who

---

<sup>2</sup> In chapter 4, I'll consider arguments for qualia based on considerations about the possibility of a so-called inverted spectrum in the context of examining arguments for dispositionalism.

propose theories of perception which can be classified as intentionalist.)

I shall consider two sorts of argument for the claim that the colors we are aware of are at least sometimes mental colors. The first sort attempts to establish that afterimage colors are mental colors. I'll consider arguments of this sort which are offered by Boghossian and Velleman, and Johnston.

The second sort of argument purports to show that some instances of perceived colors as well as some whole categories of perceived colors (such as black and brown) are explained independently of the physical properties of physical objects. According to this type of argument, our perception of at least some colors is explained in terms of the visual context and the processes of the visual system of the perceiver. Thus, the argument continues, physical properties of objects are irrelevant to perceived color; in this case, perceived color cannot be identified with physical properties of objects. Since processes of the visual system do explain perceived color in these cases, perceived color is identified with processes of the visual system. I'll consider arguments of this type which are offered by Hardin and Keith Campbell.

#### 1.3.4.1.1. Afterimage Colors

Boghossian and Velleman argue that visual experiences have mental colors in the context of rejecting intentionalist theories of perception (1989, pp. 92-94). They claim that there are cases of experience of afterimage colors which can only be explained as experiences of mental colors.

They point out that an afterimage that is represented by visual experience as an afterimage, and not (misrepresented) as a physical object, is represented as being colored. Boghossian and Velleman claim that something must be represented as being colored. Because it isn't a physical object, part of the visual field itself is represented as being colored.

Furthermore, since the afterimage is represented as an afterimage, and not a physical object, the color that the afterimage is represented as being is a property of the visual field which is not a relation to a property of a physical object. Thus, visual fields have nonrelational color properties, or as I've called them, mental colors (1989, pp. 93-94).

Boghossian and Velleman's argument assumes that if an afterimage is represented as being colored, then something is represented as being colored. If, because the afterimage is known to be an afterimage, what's represented isn't a physical object, it must be something else. The only other

thing that it could be is the visual field. (Although this claim suggests a sense datum theory of perception, Boghossian and Velleman hold that visual fields may be mental events, processes, or states. See section 1.1 above.)

But it isn't clear that Boghossian and Velleman's assumption is true. We may make the inference that if we represent an afterimage as being colored, then we represent something as being colored. But we can't make the inference that there is something that is represented as being colored. Our representation of something as being colored need not involve reference to an actual colored object (or event, process, or state) at all.

Boghossian and Velleman give no reason to deny that when we represent an afterimage as being colored, we attribute physical color to a merely intentional object. What intentional objects are, and how physical properties relate to them is indicated by a theory of intentionality (Harman, 1990, pp. 34-40). Thus, Boghossian and Velleman's arguments do not decisively show that afterimage colors are mental colors. (See Anscombe [1965], p. 171, Harman [1990], pp. 34-38, and Clark [1996b], p. 490 for similar arguments against Boghossian and Velleman's assumption.)

In "The Obscure Object of Hallucination" (unpublished manuscript a), Johnston also argues in the context of rejecting intentionalist theories that, at least in some

cases, the colors we are aware of are mental colors. Johnston claims that some categories of colors cannot be instantiated by physical objects, but rather are only colors of afterimages.

Johnston describes conditions under which one has experiences of a color called supersaturated red (p. 21). If one stares at a green patch in a dark surround for a short period of time and then looks at a white surface, one has a red afterimage. This is a standard example of what's called negative afterimage. Negative afterimage is a visual effect where after a period of intense stimulation of a particular hue, one experiences an afterimage of the hue's opponent (Hurvich, pp. 184-186).

If the red afterimage is superimposed on a red patch, then the subject experiences supersaturated red. Supersaturated red is a red that is more saturated than spectral red, that is, a narrow band of the spectrum that produces experiences of red (Hurvich, 1981, p. 187). (Saturation is the dimension of the psychological color space that maps a color's proportion of chromatic to achromatic content. Saturated colors have a high proportion of chromatic relative to achromatic content. In terms of the opponent processes, saturation is encoded by the proportion of activation of both chromatic channels relative to the sum of the activations of the chromatic channels and the achromatic channel [Hardin, 1993a, p. 35].)

Negative afterimages are explained in terms of neural properties of our visual systems. Because experiences of supersaturated red can only be produced in nonstandard viewing conditions, it can be argued that it is incorrect to attribute this shade to physical objects. Moreover, Johnston asserts, "[n]othing external, no light nor surface, is or could be supersaturated red thanks to the basic way the visual system functions" (unpublished manuscript a, p. 21). (Compare Jackson [1977, p. 35, pp. 76-77], who attempts to undermine Smart's account of color perception by examples of colors that supposedly can't be properties of physical objects.)

Since afterimage colors are explained in terms of neural properties, supersaturated red, it seems, is a neural property rather than a physical property of physical objects. Johnston concludes that afterimages do not involve intentional relations to physical colors of physical objects. Rather, he asserts, they involve nonintentional relations to neural properties (unpublished manuscript a, pp. 33-35).

As Johnston indicates, supersaturated red can be explained by the way the visual system works. For any spectral hue, it is light of a single wavelength which

produces experience of the most saturated shade of that hue.<sup>3</sup> Due to the way the opponent channels code red, there is no light of a single wavelength which is experienced as unique red, that is, a red which is neither yellowish nor bluish.

There would be a single wavelength which is experienced as unique red if there were a point in the spectrum where the yellow-blue channel is in balance and the red-green channel is excited. As it happens there is no such point. At the longwave end of the spectrum, the yellow-blue channel is slightly excited, causing single wavelengths experienced as red to always be experienced as slightly yellowish (Hardin, 1993a, pp. 37-38).

Experience of unique red is produced, rather, by a combination of wavelengths. But because it is produced by a combination of wavelengths, and not a single wavelength, unique red isn't as saturated as, for example, unique green, which is produced by a single wavelength (Hardin, 1993a, pp. 36-38; Hurvich, 1981, p. 84). Thus, unique red isn't as saturated as supersaturated red.

There are other supersaturated hues, for example, there is a supersaturated yellow. Supersaturated yellow is a yellow negative afterimage superimposed on a yellow patch.

---

<sup>3</sup> Wavelengths of light aren't themselves colored. Rather, they transmit information about colors of, for example, the surfaces of objects (Boynton, 1979, p. 24, fn. 3, pp. 50-58).

Supersaturated yellow is also explained by the way the visual system works. The opponent chromatic channels encode unique yellow, a yellow that is neither reddish nor greenish, at the point in the spectrum where the red-green channel is in balance and the yellow-blue channel is excited.

Although experience of unique yellow can be produced by light of a single wavelength, this hue is not very saturated because the single wavelength that produces unique yellow occurs at a point in the spectrum where the whiteness response is very high. In normal viewing conditions, even the unique yellow produced by a single wavelength of light is not very saturated. Thus, in the nonstandard conditions involving negative afterimage, a yellow can be experienced which is more saturated than a unique yellow produced by a single wavelength of light (Hardin, 1993a, pp. 36-37, p. 140).

Hues can be experienced as supersaturated whenever, due to nonstandard viewing conditions, the proportion of activations of the chromatic channels relative to the sum of the activations of the chromatic channels and the achromatic channel is greater than that proportion produced by a single wavelength.

Considering these explanations of supersaturated hues, Johnston's claim that there can be no physical supersaturated red is misleading. I shall focus on

Johnston's example of supersaturated red, although the type of response I shall provide can be given in the cases of other supersaturated hues.

There are people with nonstandard color vision whose L and M cones have absorption spectra that are abnormally close together. (The absorption spectra of a given cone type is represented by a graph that shows the amount of light absorbed by the cone relative to the amount of light incident for each wavelength of light.) Such people are a subgroup of so-called anomalous trichromats. (A trichromat is a perceiver for whom a mixture of three well chosen colored lights is necessary and sufficient to match the appearance of a light of any color. Such perceivers have three types of cones. For more on trichromacy, see section 1.3.4.2.)

Because of the abnormality, the differencing of the activations of the L and M cones (which encodes red and green) yields smaller values than for the normal trichromat. Thus, the proportion of chromatic response relative to both chromatic and achromatic response is also lower. These nonstandard perceivers are unable to see the most saturated reds and greens that normal trichromats can see (Boynton, 1979, p. 380).

However, it's not plausible to hold, on the grounds given, that for these anomalous trichromats, the supersaturated colors they can see only in nonstandard

viewing conditions are neural properties of their visual systems.

While Boynton and Hurvich don't address the question of the supersaturated colors experienced by anomalous trichromats, they both make predictions about the colors seen by anomalous trichromats (as well as those with other color vision defects) based on their cone activations (Boynton, pp. 380-382; Hurvich, 1981, pp. 234-239). Hurvich also refers to cases where individuals who have color deficiencies in one eye to confirm such predictions (Hurvich, 1981, p. 238).

Thus, Boynton and Hurvich provide a basis for holding that the supersaturated colors that some anomalous trichromats see in nonstandard viewing conditions are the same shades as the saturated colors that normal trichromats can see in standard viewing conditions.

Thus, the anomalous trichromat, by concluding that the supersaturated colors he can see only in nonstandard viewing conditions are neural properties of his visual system, denies that physical objects can have saturated colors that normal trichromats can see in standard viewing conditions.

Furthermore, if the anomalous trichromat's visual system were different, if it were normal, this different perceiver would be able to see the shade that's supersaturated red (according to his actual visual system) in standard viewing conditions. Similarly, if standard

human perceivers' visual systems were different so that a single wavelength would produce experiences of unique red, then these perceivers would see the shade that's supersaturated red (according to their actual visual systems) in standard viewing conditions.

Thus, it's not clear that experience of supersaturated red is awareness of a neural property. It can also be that we would experience this shade in standard viewing conditions if our visual systems were different. How do we, with our actual standard visual systems, experience a color that we would experience with a (not too) different visual system? Through manipulation of our actual visual systems, we can mimic effects produced in (not too) different visual systems.

When considering colors we experience in nonstandard viewing conditions, it's crucial to draw a distinction between a proposal about the nature of color and a theory of color perception. A proposal about the nature of color states what colors are. For example, a proposal about the nature of the colors we attribute to physical objects might state that these colors are physical properties.

A theory of color perception describes our access to colors, whatever their natures happen to be. A psychological theory of color perception describes our access to colors in terms of properties of our visual systems. A psychological theory of color perception also

indicates how our access to the properties that are colors differs due to differences in visual systems.

With respect to supersaturated red, Johnston's argument for the claim that awareness of supersaturated red is awareness of a mental color isn't conclusive for the following reason. It might be that we don't experience supersaturated red in normal viewing conditions simply because, due to the way our visual systems work, we don't have access to it. Whereas physical objects can be the shade we experience as physical supersaturated red, our visual systems prevent us from experiencing this physical property in normal viewing conditions.

But how can an afterimage of supersaturated red involve a physical color? A physical color is attributed to a merely intentional object. This isn't a special problem due to supersaturated red. Thus, Johnston's case of supersaturated red doesn't demonstrate that in experience of supersaturated red the color we are aware of is a mental color.

There are also examples of perceived colors which are held to show that the colors we are aware of are at least sometimes mental colors.

#### 1.3.4.1.2. Perceived Colors

Hardin and Campbell describe some cases of perceived colors, such as colors produced by simultaneous-contrast

effects, as colors that don't correlate with physical properties of physical objects. The apparent irrelevance of physical properties of objects to perceived colors gives us reason to question whether perceived colors are physical properties of physical objects, at least in these cases. Furthermore, perceived colors in these cases can be explained in terms of processes of our visual systems. Thus, it seems that perceived colors in these cases are mental colors.

(To be precise, Hardin doesn't identify mental colors with neural properties. Rather, Hardin claims only that visual states of color are neural states [1993a, p. 112]. He holds that colors as we experience them are explained in terms of neural processes, without specifying what the colors as we experience them are. This point noted, I'll say that according to Hardin perceived colors are mental colors.)

I shall argue that none of the examples demonstrates that the colors we are aware of in perception of physical objects are mental colors. Independently of these examples, Hardin also claims that perceived colors can't be physical properties of physical objects. I'll consider arguments for this claim in section 1.3.5.

Hardin points out that we perceive some categories of colors, such as black and brown, only due to simultaneous-contrast effects. Simultaneous contrast is a visual effect

in which a region of a particular chromatic or achromatic color tends to cause other regions of the field of view to look the color's opponent. For example, a yellow region tends to cause an adjacent grey region to look bluish grey; a white region tends to cause an adjacent black region to look darker.

Our visual systems encode black by way of the black-white opponent process. Excitation of this process encodes white, and inhibition encodes black. In photopic (or daylight) vision the black-white process is excited by the addition of the activations of the L and M cones. But the black-white process is inhibited only due to postreceptoral processes as follows.

The activation of the L and M cones in the receptive field of a set of postreceptoral neurons excites the postreceptoral neurons constituting the black-white process. (The receptive field for a postreceptoral neuron is the is the region of the retinal receptors, namely, the cones, the activation of which is encoded by the postreceptoral neuron [Hardin, 1993a, p. 12]. Adjacent receptive fields are activated by adjacent physical objects that constitute the field of view.) But the activation of L and M cones in one receptive field can also lead to the inhibition of the postreceptoral neurons constituting the black-white process in adjacent receptive fields.

The inhibition of one group of neurons brought about by

processes which excite another group is called lateral inhibition. Because black is encoded by the black-white process only as a result of lateral inhibition, we perceive black only in contrast with the lighter colors of objects in a field of view (Hardin, 1993a, pp. 12-25, p. 35; Hurvich, 1981, p. 61, pp. 166-174).

This description of the way the visual system encodes black indicates that black regions cannot be perceived independently of regions of lighter colors. Also, colors that are darkened spectral colors, for example, brown, which is a darkened orange or yellow, cannot be perceived independently of regions of lighter colors. Such colors are called contrast colors (Hardin, 1993a, pp. 23-24, p. 92; Hardin, 1990, p. 559; Hurvich, 1981, pp. 6-8, p. 61; Boynton, 1979, pp. 32-33).

What does this indicate about the nature of the black or brown we attribute to objects? Black differs from grey, and brown differs from yellow or orange on the lightness dimension of the color space (Hurvich, 1981, p. 9; Boynton, 1979, p. 33; Gouras, 1985, p. 388). (Following Irvin Rock [1975, pp. 503-504] I use the term "lightness" to refer to the white to black dimension of surface color. Some visual scientists, including Gouras, instead use the term "brightness.") Many visual scientists hold that simultaneous-contrast effects involving the colors of objects in an entire field of view always play a role in

determining perceived lightness (Hardin, 1993a, p. 53; Hurvich, 1981, p. 152; Rock, 1975, pp. 505-506).

But if, for example, brown and orange only differ with respect to perceived lightness, a surface might look either brown or orange depending on the simultaneous-contrast effects produced by objects in the field of view. In this case, it seems that brown and orange aren't physically different properties.

Furthermore, it seems that brown and orange aren't physically different, because it is the case that brown and orange differ only with respect to perceived lightness.

The physical property of physical objects which is correlated with perceived surface color is surface reflectance. Surface reflectance is a ratio of light reflected to light incident, where light is measured by both its spectral composition and its intensity at each wavelength.

Brown and orange surfaces may reflect light with the same wavelength composition. Rather, these surfaces physically differ in that brown surfaces reflect a smaller ratio of light than orange surfaces. That is, brown surfaces differ from orange surfaces with respect to the intensity of light reflected (Beck, 1975, p. 62, p. 67 [Beck compares yellow and brown], Hardin, 1990, p. 559).

However, light intensity is the physical correlate of perceived lightness. Thus, since perceived lightness is a

determined by simultaneous-contrast effects, a surface that looks orange in a dark setting looks brown in a lighter setting. In this case, simultaneous contrast, not reflectance, distinguishes orange and brown (Campbell, 1993, p. 256).

Nevertheless, the claim that orange and brown surfaces are physically different can be defended. Since brown and orange surfaces reflect different ratios of incident light, they do have different reflectance properties. Furthermore, if we relativize perceived colors to standard viewing conditions, we can distinguish orange and brown surfaces according to this difference in reflectance. For in standard viewing conditions, perceived lightness of surfaces correlates fairly well with reflectance (Hardin, 1993a, p. 84; Tom N. Cornsweet, 1970, pp. 277-283, p. 366).

There are viewing conditions in which brown objects look orange or yellow. For example, a brown chocolate bar illuminated by bright light and seen through a viewing tube (which blocks out the simultaneous contrast effects of normal viewing conditions) looks orange or yellow (Hardin, 1990, p. 559). However, these viewing conditions aren't standard. Even if the chocolate bar looks orange in these conditions, the chocolate bar is brown.

Hardin claims that because there is no scientifically principled way of specifying standard viewing conditions, claims about the nature of color cannot appeal to standard

viewing conditions (1993a, pp. 67-76; 1990, pp. 560-563).

In chapter 3, I'll examine Hardin's argument against appeals to standard viewing conditions.

For the present discussion, the important point is that if we can characterize the colors we attribute to objects in terms of standard viewing conditions, we can hold that the colors of surfaces are reflectance properties. This is because in standard viewing conditions the perceived colors of surfaces correlates fairly well with reflectance properties.

However, in some cases, when patches of color are juxtaposed or arranged as target and surround on a flat surface, simultaneous contrast produces particular instances of perceived colors where these colors are not so-called contrast colors. An example of this case is when a yellow region surrounding a grey target region causes the target to look bluish grey. (As indicated above, simultaneous contrast effects are always involved in color vision. In the case just described, color surfaces are arranged such that the contrast effect is accentuated [Hurvich, pp. 157-159].)

In this example of simultaneous contrast, if the yellow surround is blocked from view, the grey region no longer looks bluish. The bluish tinge isn't explained by the reflectance property of the grey region, but rather by excitation of the yellow-blue channel by the yellow surround

along with lateral inhibition of the yellow-blue channel.

A grey surface surrounded by yellow looks bluish due to lateral inhibition of the yellow-blue channel, which encodes blue. It looks bluish because the yellow-blue channel is affected in the way that it is affected by surfaces that are blue.

The encoding of color by the visual system determines which color a surface looks to have, and this encoding need not correlate with the reflectance property of the surface (Clark, 1993, pp. 20-26). Don't these considerations just demonstrate that the bluish tinge we attribute to a grey surface surrounded by yellow is a mental color, rather than a physical property of the surface?

Perhaps not. I'll examine this question by considering two issues. First, what is the nature of the bluish tinge: is this color a physical property or a mental property? Second, is the grey surface really bluish?

With respect to the first question, the consideration that the grey surface looks bluish due to lateral inhibition rather than due to the reflectance property of the surface doesn't show that awareness of the bluish tinge is awareness of a mental color. Rather, it shows that the colors surfaces look to have are importantly determined by their relations to other colored objects.

Although the bluish tinge to the grey surface isn't explained in terms of the reflectance property of the grey

surface itself, it is explained by the relation between the grey surface and the yellow surface. But this relation is a physical relation between two colored surfaces.

Even though the perceived colors of surfaces generally correlates with surface reflectance, this correlation sometimes breaks down. When it does, there's no demonstration that the color we are aware of is a mental color, even if the color we are aware of can be explained in terms of neural processes. For it may be that sometimes perceived colors correlate with certain physical relations among colored surfaces rather than reflectance properties of the surfaces. In this case, perceived colors still correlate with physical properties.

Is the grey surface surrounded by yellow really bluish? I think that we can say that the bluish tinge is an illusion. But what is meant by "illusion" must be treated with care. To say that the bluish tinge is an illusion isn't to say that the bluish tinge isn't correlated with any physical property. Awareness of the bluish tinge is awareness of a certain physical relation among color surfaces. Rather, the bluish tinge is an illusion because the viewing conditions aren't standard.

In viewing conditions that are standard, grey surfaces don't look bluish due to surrounding regions of yellow. Rather, the color grey surfaces look correlates with their reflectance properties; they look grey.

Furthermore, holding that the bluish tinge is an illusion doesn't give us a reason to hold that all simultaneous-contrast effects produce experiences of illusory colors. For example, surfaces are black and brown. Simultaneous contrast is always involved in color vision. It is standard.

Nevertheless, there are cases where color surfaces are arranged such that the contrast effect is accentuated. Surrounding a grey surface with yellow such that it looks bluish is an example of such a case. The accentuation of simultaneous contrast can produce experiences of illusory colors. (See Armstrong's response to Campbell, 1993, p. 273, for a similar response.)

Finally, the subjective colors produced by a Benham disk also seem to be examples of perceived colors that can't be explained in terms of physical properties of objects. A Benham disk is a round disk with a black and white pattern on its face. The face is divided along its diameter into black and white halves, and the white half has a pattern of curved black lines. When the disk is rotated between five and ten times per second, desaturated red, green, and blue rings appear along the curved black lines (Kenneth R. Boff, Lloyd Kaufman, and James P. Thomas, 1986, Ch. 9, p. 31; Hurvich, 1981, p. 190).

These colors are called Benham-Prevost-Fechner subjective colors. Since the disk is black and white, it

seems that these particular instances of perceived red and blue are explained independently of physical properties of the disk. Furthermore, the subjective colors are explained by processes of the visual system (Boff, Kaufman, and Thomas, 1986, Ch. 9. pp. 31-32; Hardin, 1993a, pp. 72-73). Thus, it seems reasonable to conclude that awareness of these subjective colors is awareness of mental colors.

As Johnston argues (1992, pp. 244-246), appeal to standard mediating processes allows us hold that the subjective colors of the Benham disk are illusory. Mediating processes are processes such as passage of light through air, which are necessary for physical properties of objects to produce visual experiences of color.

Because the Benham disk is quickly revolving, light reflected from the pattern on the face of the disk is sent to the eye at irregular intervals. The processes of the visual system which explain the subjective colors explain them in terms of the encoding of temporally irregular patterns of stimulation (Boff, Kaufman, and Thomas, 1986, Ch. 9. pp. 31-32; Hardin, 1993a, pp. 72-73; Johnston, 1992, pp. 245-246).

Because the subjective colors produced by the Benham disk are due to temporal irregularity in stimulation of the eye, we can hold that the stimulating process by which visual experience is produced isn't a standard mediating process. The colors experienced are illusory (Johnston,

1992, pp. 244-246).

Once again, holding that the color produced by the revolving Benham disk are illusory colors isn't to hold that these colors aren't correlated with physical properties. They are correlated with certain physical properties of the disk which stimulate the visual system in a temporally irregular way due to the rotation of the disk. The subjective colors are illusory because of the temporal irregularity of the stimulation.

The examples of simultaneous-contrast effects and Benham-Prevost-Fechner subjective colors serve to highlight a fact about color which should in any case be obvious: the colors that physical objects are perceived as being are relative to viewing conditions and mediating or stimulating processes.

Throughout my discussion of these examples, I have appealed to standard viewing conditions or standard mediating processes. Characterizing the colors of objects in terms of standard conditions and mediating processes faces a variety of objections (Hardin, 1993a, pp. 67-98; Hardin, 1983). I'll consider these objections to standardization in section 3.2.2.2.

(Another reason offered to indicate that the colors we are aware of are mental colors involves the differences among individuals with respect to the perceived colors produced by physical properties. For example, a physical

stimulus that looks a shade of green which is not at all yellowish or bluish to one person can look slightly yellowish or bluish to another person. I shall consider this case in chapter 4, and propose to relativize the colors of objects to standard perceivers. I'll consider objections to characterizing colors in terms of standard perceivers along with those to characterizing colors in terms of standard conditions.)

In considering visual effects such as simultaneous contrast it's once again crucial to draw a distinction between a proposal about the nature of color and a theory of color perception. Even though we have access to the reflectance properties of surfaces only by way of simultaneous contrast, the colors of physical objects might still be reflectance properties. Thus, a physicalist proposal about the nature of color is consistent with a psychological theory of perception which explains access to reflectance properties by way of simultaneous contrast.

Furthermore, this distinction is important when considering colors we experience in nonstandard viewing conditions. We sometimes say that the colors perceived in nonstandard viewing conditions are illusory. In this case, perceived colors might be physical properties, but just not the physical properties we perceive in standard viewing conditions.

Thus, the perceived colors in nonstandard viewing

conditions might not be, for example, reflectance properties, the physical properties proposed by physicalism to be the colors of surfaces. However, as long as a psychological theory of color perception can explain illusory colors in terms of physical properties of physical objects, there's no reason to conclude that illusory perceived colors are mental colors.

Hardin provides a variety of additional arguments for the conclusion that physical objects aren't colored and thus that the colors we are aware of in perception are always mental colors. However, if we must accept that the colors we are aware of in perceiving objects are at least sometimes mental colors, we'll have less resistance to arguments for the stronger claim that the colors we are aware of in perception are always mental colors (Hardin, 1993a, p. 82).

For example, if we admit that perceived colors are sometimes mental colors, then we're faced with the serious problem of explaining how mental colors can be perceived as properties of mind-independent objects. If we're already faced with this problem given considerations about simultaneous-contrast effects, we'll lose one of the main objections to the claim that perceived colors are always mental colors, namely, the objection that a subjectivist proposal about color can't explain color perception.

However, if we describe perceived colors such as those produced by accentuated simultaneous contrast as physical

properties but illusory colors due to nonstandard viewing conditions, these simultaneous-contrast effects give us no reason to accept that sometimes perceived colors are mental colors.

Next, I shall attempt to motivate mental colors on grounds independent of the possibility that the colors we're aware of are ever mental colors.

#### 1.3.4.2. The Determination of Color Categories

I motivate calling certain neural properties mental colors by pointing out that, as color science shows, these neural properties importantly determine our color categories. This motivation for mental colors is thus neutral as to whether the colors we are aware of in afterimages and hallucinations are ever mental colors.

Psychological research on color vision shows that properties of the visual system play a crucial role in determining our discriminations of perceived colors as qualitatively the same or different as well as qualitatively similar or dissimilar.

Hardin points out that our classifications of perceived colors as qualitatively the same or different are importantly determined by neural processes. Objects with different surface reflectance properties can produce the same color experiences in perceivers.

To illustrate, an object with a surface that reflects

only 577 nanometer light looks a shade of yellow to most human perceivers. (The nanometer is the standard unit of measure of the wavelength of light.) By adjusting the intensity of incident light, an object with a surface that reflects only 540 nanometer and 670 nanometer light, and thus with no 577 nanometer light at all, can be made to look the same shade of yellow. In fact, an indefinitely large group of physical properties with little in common independent of their relations to the human visual system are sensed as being the same color. Physically distinct properties that are experienced as the same color are called metamers (Hardin, 1993a, p. 46, pp. 62-64).

The law of trichromacy describes conditions under which physical properties produce experiences of the same color, where colors are qualitatively identical if they match on the dimensions of hue, brightness and saturation.

(Brightness is the dimension the color space for the colors of lights along which lights are mapped as dim to very bright.) According to trichromacy, by changing the intensities of the components of a light composed of three well-chosen wavelengths, this light mixture will match the appearance of a light of any color.

Trichromacy is explained by properties of neural processes. Any two lights that have an identical effect on the three types of cones will be identical in appearance. The light mixture can be made to match the appearance of a

light of any color because it can be made to have the same effect on the cones as a light of any color (Cornsweet, 1970, pp. 170-172; Teller, 1991). Furthermore, aspects of color appearance, such as hue, are determined by aspects of the activation of the cones. For example, visual sensations of specific hues are associated with specific ratios of activation of the three types of cones (Cornsweet, 1970, pp. 243-257; Clark, 1993, p. 44).

The opponent channels encode these ratios of stimulation of the three cone types. Indefinitely many physical properties of objects can produce, for example, mental red because indefinitely many physical properties of objects can produce the ratio of cone stimulation which is encoded by mental red (Hardin, 1993a, pp. 26-40).

Also, as I discuss in section 1.3.2., properties of the visual system play an important role in determining the qualitative similarity relations among perceived colors. Thus, psychological research on color vision supports the claim that there are properties of visual experience which are important in determining color categories.

Due to the role of properties of neural processes in determining color categories, perceived colors correspond with properties of neural processes. Thus, the property red we perceive physical objects as having corresponds with a neural property that encodes red. Furthermore, the qualitative similarity relations among perceived colors, for

example, the qualitative similarity between the properties red and orange that we attribute to physical objects, correspond with qualitative similarity relations among properties of neural processes that encode perceived colors.

Because the relations among the members of the range of perceived colors correspond with the relations among the members of the range of neural properties that encode perceived colors, perceived colors and these neural properties are analogous ranges of properties.

There are also disanalogies. We are aware of the qualitative similarity relations among perceived colors in visual experience. We aren't aware of the qualitative similarity relations among properties of neural processes in this way. (See Wilfrid Sellars, 1956, pp. 323-324 and 1963a, pp. 418-419, for a similar description of the analogy between two ranges of color properties.)

Nevertheless, it's because members of the range of neural properties that encode perceived colors importantly determine perceived color categories that the analogy between the two ranges of properties holds. Due to the analogy, we may call range of properties of neural processes mental colors.

However, because I allow that it's possible we're never aware of neural properties as colors, one may wonder whether it's correct to call such properties colors. According to many theorists, the colors we are aware of must determine

and explain the color categories; it seems that two requirements for any range of properties to be identified with colors are, first, that we are aware of members of the range as colors and, second, that members of the range determine the color categories.

I claim, to the contrary, that what seemed to be requirements for a single range of properties to be identified with colors are divided between two distinct ranges of properties. These two distinct ranges of properties have been melded together, primarily due to the assumption that descriptions of our ordinary experience of colors specifies the nature of color. Rejecting this assumption, we can pry the two ranges of properties apart, and provide a satisfying account of color.

Furthermore, arguments that hold that the colors we are aware of are even sometimes mental colors must rest on a variety of controversial claims. For example, it's not clear how we could be aware of mental colors in afterimages or hallucinations. At the same time, it's also not clear how we could be aware of physical colors in afterimages or hallucinations.

Due to the controversy and lack of clarity about these issues, it's a strength of my argument that it doesn't rely on the claim that the colors we are aware of are sometimes mental colors. However, it's also a strength of my argument that it is consistent with our being aware of mental colors

in afterimages or hallucinations, if reasons can be produced in favor of our being aware of mental colors in such cases.

If such reasons can't be produced, then, since I hold that it's possible the only qualitative properties we are aware of are physical qualitative properties of physical objects, my argument for motivating mental color is consistent with intentionalist theories of perception.

#### 1.3.5. Are Physical Objects Colorless?

Because neural processes are important in determining our perceived color categories, we have good reason to hold that properties of neural processes are mental colors. Hardin takes the argument a step further. He claims that because the physical properties of objects which are experienced as red are members of an indefinitely large group with little in common independent of their relations to the human visual system, red cannot be a physical property of objects (1993a, pp. 62-66, pp. 80-81).

Since qualitative similarity relations are also determined by properties of the visual system, and not by physical properties of objects, there is further reason to hold that colors are neural processes but not physical properties of objects (1993a, p. 7, pp. 65-66; 1990, pp. 564-566).

Both of these arguments are founded on what I call the metaphysical constraint on the nature of color, which holds

that a description of color according to our ordinary experience provides a specification of at least an aspect of the nature of color. Both arguments assume that for any range of physical properties to be identified with color, the members of the range of properties must be intrinsically related in ways that correspond with the qualitative relations among colors which we are aware of in ordinary experience.

However, we shouldn't conclude that the colors we attribute to objects aren't physical properties of objects. The neural properties I identify with mental colors abstract from a great many physical differences among objects. Distinguishing between the neural properties and the physical properties of objects which are encoded, we can hold that the colors attributed to objects are physical properties even while these physical properties are encoded by mental processes that abstract from physical differences.

In this case, our awareness of physically distinct surfaces as having the same color property is not an awareness of our encoding processes. It is an awareness of an identity among surfaces. The surfaces are identical at the level of abstraction from physical properties at which our mental encoding processes operate. (See Armstrong, 1987, pp. 9-10, for a similar view.)

Thus, the physical properties that we experience as the same color aren't identical at the level of physical

description. They are members of indefinitely large disjunctions of physical properties of objects. But we don't experience these physical properties as disjunctive because mental colors abstract from physical differences. (Whether or not the disjunctivity of the physical properties experienced as the same color provides a good reason to deny that colors are physical properties of physical objects is an issue that I shall examine in chapter 5.)

Also, Hardin claims that any range of physical properties that is a tenable candidate for being colors must explain the qualitative similarity relations among colors. But there are no physical properties of objects that do explain the qualitative similarity relations (Hardin, 1993a, p. 7).

It isn't clear why the disjunctive physical property picked out by mental red must explain the qualitative similarity relations of mental red to other mental colors. Drawing a distinction between mental colors and the physical properties of objects encoded by mental colors allows one to hold that the qualitative similarity relations are explained by mental colors. Thus, they are explained independently of relations among physical properties of objects.

McGilvray poses the problem about qualitative similarity relations in the following way. (Hardin poses the problem in a related, but slightly different way [1993a], p. 66. For a related discussion of the issue, see

Clark, 1993, pp. 182-184.) McGilvray claims that qualitative similarity relations among colors are intrinsic to colors (1994, p. 202).

By this claim, McGilvray places the following constraints on the identification of any range of properties, such as reflectance properties, with colors. First, a range of properties may be identified with colors only if the qualitative relations among these properties are similar to those represented in the color space (1994, pp. 202-203). Second, members of the range of properties must be ordered in these relations intrinsically, that is, the whole range of properties must not be ordered in this way in virtue of relations of members of the range to members of a distinct range of properties (1994, pp. 202-203).

The second constraint is an example of the metaphysical constraint on the nature of color. According to McGilvray, a description of our ordinary experience of qualitative similarity relations among colors provides a specification of at least an aspect of the nature of color.

Visual science shows that physical properties of objects, such as reflectance properties, aren't intrinsically ordered in the relations represented by the color space. Rather, reflectance properties are ordered in qualitative similarity relations only extrinsically--in virtue of their relations to mental colors. Thus, McGilvray concludes that monadic physical properties, such as

reflectance properties, cannot be identified with colors (1994, pp. 202-203).

The qualitative similarity relations among the colors we perceive provide conceptual constraints on any mental property identified with mental colors. In the same way, the qualitative similarity relations provide conceptual constraints on any physical property identified with the colors of objects. But in neither case do the qualitative similarity relations provide us with a specification of the nature of color.

The qualitative similarity relations among the colors we attribute to objects are importantly determined by mental colors. The color categories are extrinsic to the colors of physical objects. However, unless we assume that the qualitative similarity relations specify the nature of physical colors, the fact that color categories are importantly determined by mental colors doesn't demonstrate that physical objects are colorless.

For unless we make this assumption, we can draw a distinction between mental colors, namely, the neural properties that play a role in determining color categories, and the physical properties of objects that are categorized. Moreover, as I'll argue in chapter 2, there's good reason to believe that the colors we are aware of in perception of physical objects are physical properties of those objects. In this case, there's good reason to believe that physical

objects are colored.

Hardin's argument for the claim that the colors we attribute to physical objects are mental colors, which draws from findings in color science, is not the only type of argument for this claim. Boghossian and Velleman support this claim by arguments that make no use of empirical science. They hold that there are epistemological and phenomenological grounds for the claim that the colors we attribute to physical objects are mental properties of visual experiences. In the next chapter I shall evaluate these arguments.

## 2. Boghossian and Velleman's Subjectivism

Boghossian and Velleman ask the following questions regarding the contents of visual experiences of colors. Is the property red that we attribute to physical objects in virtue of our visual experiences a monadic physical property of physical objects, or is it a mental color? Or, is the property red that we attribute to physical objects a relation between a physical property of physical objects and a mental color (1989, pp. 81-82, pp. 94-96; 1991, p. 68)?

Boghossian and Velleman claim that the colors we attribute to physical objects in visual experiences of color are mental colors (1989, p. 96). This claim is based on arguments that conclude that visual experiences have mental colors and that colors are not properties of physical objects. They claim that since physical objects don't have the mental colors that we attribute to them, the attribution of color to physical objects is systematically erroneous (1989, pp. 96-97).

In chapter 1, I considered Boghossian and Velleman's arguments for the claim that visual experiences have mental colors. I accepted their conclusion that visual experiences do have mental colors, although I rejected their arguments for this conclusion. In this chapter I will consider

Boghossian and Velleman's arguments for the claim that physical objects aren't colored.

### 2.1. Arguments against Physical Color

Boghossian and Velleman claim that colors attributed to physical objects in visual experience aren't properties of those objects. They argue against the view that colors are physical properties of objects, such as reflectance properties of their surfaces, on the basis of claims about our knowledge of qualitative relations among colors. They argue against the claim that colors are dispositions of physical objects to produce visual experiences of color on phenomenological grounds (1991, pp. 84-85).

Although I accept that there are mental colors, I also hold that there is a distinct range of physical colors. I shall view Boghossian and Velleman's attacks on both physicalism and dispositionalism as attacks on the distinction between mental color and physical color.

#### 2.1.1. An Argument against Monadic Physical Color

In their subtle and provocative article "Physicalist Theories of Color" (1991), Boghossian and Velleman claim to refute a group of proposals about the nature of color, which they call physicalist theories. Such theories have in common the claim that the colors we attribute to physical objects are physical properties of objects (1991, p. 67). I shall respond to the argument they give against physicalism

as this view is proposed by Armstrong and Smart.<sup>1</sup> I'll show that Boghossian and Velleman's argument misses its target, and that at least Armstrong and Smart's kind of physicalism about color remains tenable.

Before presenting their argument, Boghossian and Velleman develop an elaborate scheme for classifying varieties of physicalism (1991, pp. 72-84). At the broadest level, they claim, physicalist theories divide into two sorts (1991, pp. 77-78).

One sort holds that the colors attributed to objects are physical properties of objects identified by their particular mental effects (1991, p. 78). According to this view, we are aware of the colors of objects only through being aware of their mental effects (1991, pp. 82-84). They claim that proponents of this variety of physicalism include Jackson and Robert Pargetter (1987), and Shoemaker (1990) (1991, p. 78).

The other sort of physicalist view holds that the colors attributed to objects are physical properties of objects which we are directly aware of. Thus, we classify objects by color through direct awareness of physical identities, similarities, and differences (1991, pp. 77-81). Our awareness of the colors of objects isn't mediated by

---

<sup>1</sup> Boghossian and Velleman provide an abbreviated version of their argument against Armstrong's and Smart's variety of physicalism in their (1989), pp. 82-83.

awareness of their mental effects. Boghossian and Velleman attribute this sort of physicalism to Armstrong and Smart (1991, p. 78).

While their broadest division is an epistemological one, for it distinguishes physicalists according to views about how colors are identified, it corresponds to a division of physicalists with respect to views about the nature of perceptual states of color. Jackson and Pargetter, and Shoemaker hold that perceptual states of color have mental qualitative properties that are distinct from the physical colors of physical objects (Jackson and Pargetter, 1987, pp. 130-131; Shoemaker, 1996).

For example, Jackson and Pargetter claim that physical colors are whatever physical properties are the bases of the disposition of physical objects to produce visual experiences of color (1987, pp. 130-131). Thus, the colors of objects are necessarily related to visual experiences of color. Visual experiences of color, in turn, must be characterizable in terms of mental qualitative properties that are distinct from the colors of objects.

By contrast, physicalism as proposed by Armstrong and Smart deny that visual experiences of color have mental qualitative properties. They characterize perceptual states of color in terms of their representational properties, which are causal relations of such states to physical colors (Armstrong, 1984, pp. 170-172; Smart, 1975, p. 61, and

1995). (Armstrong, 1993, pp. 270-271 and Smart 1995, p. 545, distinguish their proposal about the nature of perceptual states of color from that of Jackson and Pargetter in the ways that I describe.) At bottom, perceptual states of color are understood in terms of neurophysiological properties (Armstrong 1987, pp. 9-11; Smart 1975, pp. 56-57). (See also Lewis, 1995; Lewis, forthcoming, pp. 2-3, for this view.)

Since Armstrong's and Smart's characterization of the nature of visual experience of color fits with intentionalist theories of perception, I'll call their proposal about the nature of the colors of physical objects intentionalist physicalism.

I'll defend Armstrong's and Smart's proposal about the nature of physical color. This proposal holds that the colors of objects are physical properties, such as reflectance properties of their surfaces, which are not necessarily related to visual experiences of color.

I don't accept Armstrong's and Smart's claim that the only qualitative properties of perceptual states are properties such as physical colors, for I hold that there are also mental colors. Nevertheless, my proposal about the nature of perceptual states of color is consistent with intentionalist theories of perception. In particular, I reject Shoemaker's characterization of mental colors as qualia.

I shall show that Boghossian and Velleman's argument against intentionalist physicalism relies on characterizing it according to their epistemological division, and that the proponent of this view must reject this characterization.

#### 2.1.1.1. Boghossian and Velleman's Epistemological Challenge

Boghossian and Velleman approach the question of the nature of color by considering the nature of the properties objects appear to have in looking colored (1991, p. 68). The property an object appears to have in looking colored, they hold, includes any color an object seems to have in a viewing context that may or may not be considered standard (1989, p. 83, pp. 102-103).

Because the colors objects appear to have--or, as they say, apparent colors--include the colors that objects only seem to have in nonstandard viewing contexts, we need not attribute these colors to objects at all. Furthermore, apparent colors are the colors that we are conscious of when we introspect our visual perceptions (1991, p. 85). Thus, apparent colors are the colors that we are aware of through visual perception or introspection.

According to intentionalist physicalism, apparent colors are monadic physical properties of physical objects. Boghossian and Velleman's argument against this view challenges its proponent to account for our knowledge of relations among apparent colors.

We know, for example, that apparent red and apparent orange are distinct apparent colors. Since apparent colors just are the colors we are aware of through visual perception and introspection, mere awareness of colors through perception or introspection provides us with knowledge of the relations among them (1991, p. 85).

Furthermore, Boghossian and Velleman assert that knowledge of the relations among apparent colors is all that's required for us to know the essential nature of color. Thus, they endorse what I call the epistemological constraint on the nature of color:

Red and orange--that is, the properties that things appear to have in looking red and in looking orange--not only are distinct, similar determinates of the same determinable but are essentially so. A property that wasn't a determinate of the same determinable as red, or wasn't distinct from red, or wasn't similar to red--such a property simply wouldn't be orange. And vice versa (1991, p. 85).

Also, since our knowledge of relations among apparent colors is sufficient for knowing the essential nature of color, it is certain (1991, p. 86, 97). If such knowledge wasn't certain, "[we] would have to consider the possibility of obtaining evidence that red and orange are in fact the same property or, conversely, that they aren't similar at all" (1991, p. 86). But, they claim, it is not possible to obtain such evidence (1991, p. 86).

Since Boghossian and Velleman hold that visual experience provides us with access to the nature of color,

but offer no qualification on how complete the access is, they hold a strong version of the epistemological constraint. (I'll show that Johnston, for example, claims that visual experience provides access to only an aspect of the nature of color. Thus, he holds a weaker version of the epistemological constraint.)

With a description of Boghossian and Velleman's claims about our knowledge of relations among apparent colors, we can better understand their epistemological challenge for the physicalist. The challenge is to account for our certainty, obtained merely from awareness of colors, that, for example, the property objects appear to have in looking red and the property they appear to have in looking orange are distinct (1991, pp. 86-87).

#### 2.1.1.2. Boghossian and Velleman's Epistemological Argument

Boghossian and Velleman argue convincingly that if our knowledge of relations among apparent colors is certain, and we obtain certainty merely from awareness of colors, then apparent colors cannot be monadic properties of physical objects.

Intentionalist physicalism proposes to the contrary that the propositional content of perceptual states of color includes monadic physical properties of objects, for example, reflectance properties. The perception that two objects have the same color just is the perception that two

objects have the same physical property.

But if apparent colors are monadic physical properties of objects, scientific investigation would be necessary for one to be certain which colors one's perceptual states represent. In this case, one can't be certain, merely from awareness of color, whether the property objects appear to have in looking red and the property they appear to have in looking orange are distinct. If physicalism is true, then ". . . one cannot always tell without investigation whether red and orange are different colors . . . ." (1991, p. 91).

Furthermore, it would be possible for scientific investigation to discover, for example, that the property objects appear to have in looking red and the property objects appear to have in looking orange are the same property (1991, pp. 90-91). Thus, if we are certain, merely from awareness of color, that the property objects appear to have in looking red and the property they appear to have in looking orange are distinct, intentionalist physicalism is false (1991, pp. 85-91).

#### 2.1.1.3. The Physicalist's Response

Boghossian and Velleman's approach to the issue of the nature of color is to consider the nature of the properties objects appear to have in looking colored. The physicalist can accept this approach. Taking it, this theorist claims that the properties objects appear to have in looking

colored are physical properties of objects. But the physicalist must resist Boghossian and Velleman's assumption that awareness of colors through visual perception and introspection is all that's required for us to know the nature of color.

Moreover, Boghossian and Velleman's assumption causes them to seriously misrepresent the views of Armstrong and Smart. Boghossian and Velleman's broadest division of varieties of physicalism distinguishes physicalists by their epistemological views. They say some hold that colors are identified by our awareness of the particular perceptual effects of physical properties of objects. Others hold that colors are physical properties of objects which we are directly aware of.

But while physicalists differ with respect to the nature of perceptual states of color, physicalists of all varieties account for our classifications of objects by color in terms of the perceptual effects of colors. As an illustration, Armstrong (1987, pp. 9-10) and Smart (1975, pp. 56-57) account for our identification of different physical properties as the same color in terms of sameness of perceptual state.

Boghossian and Velleman ignore this aspect of intentionalist physicalism because they claim that we identify colors by perceptual effects only in a very specific way. They claim that if we identify the colors of

objects by perceptual effects, the colors we are aware of in perception of colored objects are qualitative properties of perceptual states themselves, which function as mental intermediaries (pp. 82-84). (Those, for example, Shoemaker, who characterize visual experiences in terms of qualia needn't accept, as Boghossian and Velleman claim, that the colors we are aware of in visual experience are qualia. See the dispositionalist's response to Boghossian and Velleman's claim, section 2.1.2.3. below.)

However, Boghossian and Velleman reject without argument any physicalist view that proposes that we identify colors by perceptual effects, where these perceptual effects aren't mental qualitative properties (p. 82). This is just to beg the question against Armstrong's and Smart's view. For they accounts for our classifications of objects by color due to properties of perceptual states in terms of representational properties, rather than mental qualitative properties, of perceptual states.

The representational properties of perceptual states can be understood in terms of neurophysiological properties. Two physical surfaces that differ in reflectance properties may be indiscriminable with respect to color. In such a case, the two surfaces produce the same activation of the cones. The surfaces are the same color due to the way our visual systems encode physical colors. Still, according to intentionalist physicalism, our awareness of colors is an

awareness of a property of the surfaces, not an awareness of our encoding processes themselves.

As Boghossian and Velleman claim, if physicalism is true, we can't be certain, merely from awareness of color, that the property objects appear to have in looking orange and the property they appear to have in looking brown are different colors. But by drawing a distinction between the colors of objects and the mental properties that play a role in identifying the colors of objects, the physicalist can explain that, in fact, we aren't certain of this at all.

According to some theorists, for example, Campbell (1993, p. 256), scientific investigation indicates that perceptions of orange and brown surfaces of objects are associated with the same group of reflectance properties. These surfaces look to have different colors due to effects of the viewing context, for example, simultaneous contrast. (I describe simultaneous contrast, as well as Campbell's argument, in section 1.3.4.1.2.).

If the colors of objects' surfaces are reflectance properties, then, according to Campbell, orange and brown are the same physical color property. Rather than assume that scientific investigation simply cannot indicate that orange and brown are the same color, intentionalist physicalism draws a distinction between physical colors and their perceptual effects.

By drawing this distinction, a difference of perceptual

state of color is consistent with the sameness of physical color. A psychological theory of color perception would show how, due to visual context effects such as simultaneous contrast, perceptual states of orange and of brown are perceptions of the same color. Such a theory would indicate that perceptual states of orange and of brown are in a sense illusory.

As I pointed out in chapter 1, orange and brown are different physical colors. Surfaces that are brown may reflect light with the same wavelength composition as surfaces that are orange. Because of this, surfaces that are brown may look orange in some viewing conditions. But in standard viewing conditions, orange and brown surfaces are perceived as different colors, and this difference correlates with a difference in reflectance (Beck, 1975, p. 62, p. 67 [Beck compares yellow and brown]). Thus, in standard viewing conditions perceptual states of orange and brown are associated with difference reflectance properties. (I'll defend the notion of standard viewing conditions in chapter 4.)

Nevertheless, according to intentionalist physicalism it's possible that physical orange and brown are the same physical color.

Once again, the distinction between a proposal about the nature of color and a theory of color perception is important. According to a physicalist proposal about the

nature of color, all of the apparent colors are physical properties.

However, sometimes, for example, due to some simultaneous-contrast effects, apparent colors of surfaces don't correlate with reflectance properties. In such a case, the physicalist holds that the apparent color is illusory, and explains it in terms of a psychological theory of color perception. But we can't be certain, from mere awareness of color in visual experience, whether an apparent color, or even a whole color category such as brown, is an illusory color. For we can't be certain, from mere awareness of color, whether the viewing conditions and mediating processes are standard. In some cases, we might find, to our surprise, that they're not.

Furthermore, the distinction between physical colors and their perceptual effects allows intentionalist physicalism to hold that we indeed know, merely from awareness of the colors of objects, the qualitative relations among colors. Neurophysiological and psychophysical investigation shows that the perceptual effects of physical colors on our visual systems play an important role in determining the qualitative relations among physical colors (Cornsweet, 1970, pp. 170-172; Hurvich, 1981, pp. 128-135).

Nevertheless, we do not come to know these qualitative relations by being directly aware of these perceptual

effects, as Boghossian and Velleman hold. Rather, we come to know them through our awareness of physical colors.

For the most part, we classify perceptual states of color with respect to physical colors. Ordinarily we have no other knowledge of these perceptual states. Perceptual states of physical red are distinguished from those of physical orange due to the difference between these physical colors. As the example of simultaneous contrast shows, it's possible that qualitative relations among perceptual states of color are due to context effects and can be considered illusory. But typically, our knowledge of the qualitative aspect of our perceptual states of color is just in terms of qualitative relations among the physical colors.

Thus, although the perceptual effects of physical colors play an important role in determining qualitative relations among physical colors, this gives us no reason to hold that our knowledge of the qualitative relations is certain. Ordinary knowledge of qualitative relations among our perceptual states provides us with no access to the neurophysiological nature of the mental effects of physical colors (Armstrong, 1987, p. 10; also see Lewis, 1995; Lewis, forthcoming, pp. 2-3, for this view.)

But then Boghossian and Velleman's claim that our knowledge of the relations among colors is certain just assumes that knowledge of the appearances of colors in perception is sufficient for knowing the essential nature of

color. By making this assumption, Boghossian and Velleman simply rule out the physicalist's position. Without an argument for their assumption, Boghossian and Velleman fail to even seriously consider the claim that the colors of objects are monadic physical properties.

Since Boghossian and Velleman's argument against physicalism gives us no reason to deny that the colors we attribute to physical objects in visual experience are physical properties of objects, it gives us no reason to reject the distinction between physical color and mental color.

Next, I will consider whether Boghossian and Velleman provide reasons to reject dispositionalism. According to most current versions of dispositionalism, the colors we attribute to physical objects are dispositions of physical objects to produce visual experiences with color qualia, mental colors that are necessarily conscious. Physical colors are relations between physical properties of objects and color qualia. Described this way, dispositionalism requires a distinction between physical color and mental color.<sup>2</sup>

---

<sup>2</sup> There are types of dispositionalism that propose that the colors of objects are relations of physical properties of objects to nonqualitative responses in perceivers, such as discriminatory behavior (see, for example, Smart, 1961). Since such types of dispositionalism don't characterize perceptual states in terms of mental colors, they don't require a distinction between physical color and mental color.

Although I reject the characterization of mental colors as qualia and physical colors as dispositions, I support drawing a distinction between physical color and mental color. Thus, I'll defend the dispositionalist's distinction against Boghossian and Velleman's arguments.

### 2.1.2. Arguments against Dispositionalism

In their influential article "Colour as a Secondary Quality" (1989), Boghossian and Velleman examine and reject the claim that colors are dispositions of physical objects to produce visual experiences of color. They reject dispositionalism on phenomenological grounds.<sup>3</sup> I shall challenge Boghossian and Velleman's case against dispositionalism. I'll argue that, due to their failure to draw a distinction required for a tenable dispositionalism, they neglect to even address the dispositionalist proposal.<sup>4</sup>

They characterize dispositionalism as holding the following claim as an a priori truth:

---

<sup>3</sup> Boghossian and Velleman's arguments against dispositionalism appear to have convinced Thompson (1995, pp. 31-32) and McGinn (1996, pp. 538-544). McGinn, formerly a proponent of dispositionalism, now rejects this view largely due to considerations put forward by Boghossian and Velleman.

<sup>4</sup> In their "Colouring in the World" (1990), John Bigelow, John Collins and Robert Pargetter also defend dispositionalism against Boghossian and Velleman's attack, but without focusing on the conflation that I take to be basic to the failure of Boghossian and Velleman's arguments.

- (1)  $x$  is red if and only if  $x$  appears red under standard conditions.

While (1) may be a claim shared by dispositionalists, it leaves their proposal about the nature of color unspecified. Such a specification is provided by what Boghossian and Velleman call content dispositionalism. They hold that content dispositionalism makes the following claim:

- (2) red (i.e., the property objects are seen as having when they look red) = def a disposition to appear red under standard conditions

In fact, (2) is also a claim shared by dispositionalists. What Boghossian and Velleman call content dispositionalism is just dispositionalism characterized in terms of its distinctive specification of the propositional content of visual experience of color. This specification holds that the property red as it figures in the content of visual experience is a disposition to appear red, that is, a disposition of physical objects to produce visual experiences of red.

It is with this specification of content that the contrast between dispositionalist and physicalist proposals about the nature of color becomes clear. Physicalism denies that the property red we attribute to objects is a dispositional property, and rather proposes that it is a nonrelational physical property of objects such as surface reflectance.

Also, with this specification of content Boghossian and Velleman draw a distinction between two versions of dispositionalism on the basis of two ways that dispositionalists characterize visual experiences of color (1989, pp. 85-86). They contend that each version faces overwhelming objections.

#### 2.1.2.1. Arguments against Pure and Qualified Dispositionalism

Boghossian and Velleman assert that according to one version, which they call pure dispositionalism, visual experiences of red are defined in terms of the property red that we attribute to physical objects. Thus, the property red we attribute to objects is a disposition of objects to produce visual experiences of red, which are defined in terms of the property red itself (1989, pp. 85-86).

Boghossian and Velleman argue decisively that pure dispositionalism holds an untenable characterization of visual experiences of color. We run into vicious circularity if we both define the color we attribute to objects in terms of visual experiences of color and also define visual experiences of color themselves in terms of the color we attribute to objects.

As an illustration, according to (2), the property red is defined as a disposition to appear red under standard conditions. On pure dispositionalism, "red" as it occurs in "a disposition to appear red" also refers to the property

red attributed to objects. Thus, "a disposition to appear red" is rendered "a disposition to appear as a disposition to appear red." And so on, ad infinitum (1989, pp. 89-91).

Boghossian and Velleman attribute pure dispositionalism to, for example, McDowell and McGinn (1989, p. 85, n. 7, p. 89, n. 10). But McDowell and McGinn do not define visual experiences of color in terms of the colors we attribute to objects (McDowell, 1985, p. 124, fn. 6; McGinn, 1983, pp. 6-8). (Boghossian and Velleman's warning of the resulting vicious circularity isn't news to dispositionalists. See Chisholm 1966, pp. 381-382 for the same considerations.)

Although Boghossian and Velleman identify only Peacocke as a proponent of what they distinguish as the other version of content dispositionalism (1989, p. 86), McDowell, McGinn, and other proponents of dispositionalism are better classified as holding it as well.<sup>5</sup> According to this alternative version, the property red we attribute to objects is a disposition of objects to produce visual experiences of red, which are defined in terms of color qualia (1989, p. 86).

(McDowell and McGinn do not describe visual experience in precisely the same terms as Peacocke. Nevertheless, the three have similar notions of visual experiences and of color qualia. Peacocke describes qualia as "properties an

---

<sup>5</sup> McGinn (1996) has recently rejected dispositionalism.

experience has in virtue of some aspect--other than its representational content--of what it is like to have that experience" [1983, p. 5]. Both McDowell [1985, pp. 113-114] and McGinn [1983, pp. 8-9] indicate that qualia are to be described in terms of the subjectivity of experiential states. McGinn, citing Nagel, adds that subjectivity is to be understood in terms of being "accessible only from a particular experiential point of view" [1983, p. 9].)

To make the distinction between color qualia and physical colors clear, Boghossian and Velleman adopt Peacocke's useful convention of referring to color qualia by primed predicates, such as "red'" (1989, pp. 91-92).

According to the alternative version, which they call qualified dispositionalism, (2) is modified as follows:

(2') <u>red</u> (i.e., the property objects are seen as having when they look red)	= def	a disposition to appear red' under standard conditions
--	-------	--

Visual experiences of red are defined in terms of red' and thus may be understood independently of the red we attribute to physical objects. Thus, qualified dispositionalism avoids infinite regress.

But Boghossian and Velleman claim that by drawing the distinction between red and red', qualified dispositionalism is vulnerable to a devastating phenomenological objection. According to qualified dispositionalism, the property objects are represented as having when they look red is a relation between physical properties of objects and red'. A

specification of the propositional content of visual experience of red makes reference to red'.

Thus, Boghossian and Velleman claim, dispositionalism is committed to holding that a description of red as we are conscious of it in visual experience also makes reference to red' (1989, p. 94). But if so, we must be conscious of red' either as a property of physical objects or as distinct from the properties of physical objects.

A proponent of dispositionalism can't hold that we are conscious of red' as a property of physical objects. If we were, then the property we attribute to physical objects would be a color quale, not a disposition of objects, and dispositionalism would be false. Rather, this theorist must hold that we are conscious of red' as distinct from the color we attribute to physical objects. But this proposal is clearly phenomenologically false. In visual experience, we aren't conscious of red' as distinct from the property red we attribute to objects (1989, pp. 94-96).

Thus, it seems that Boghossian and Velleman have refuted both versions of content dispositionalism. Also, it seems that they have refuted the only options available to the dispositionalist for specifying the content of visual experience of color. If visual experiences of red cannot be defined either in terms of perceptible qualities or color qualia, then it seems dispositionalism can provide no understanding of visual experiences of red. Since

dispositionalism defines the property red in terms of visual experiences of red, it offers an untenable proposal about the nature of color.

#### 2.1.2.2. A General Argument against Dispositionalism

Boghossian and Velleman's objection to qualified dispositionalism is only one of two arguments for the claim that dispositionalism cannot make sense of a phenomenological description of color, that is, a description of color as we are aware of it in visual experience. The second argument attacks dispositionalism in general.

According to Boghossian and Velleman, because dispositionalists claim that the property red we attribute to objects is a disposition to look red, this theorist is committed to holding that an appearance of red is an appearance of a disposition to look red (1989, p. 87). But, they argue, in some cases an appearance of red can't be understood in terms of an appearance of a disposition. If we know that a red afterimage is in fact an afterimage, then the afterimage appears to exist only for as long as we are aware of it. Thus, the afterimage can't appear to have a disposition. Only what appear to be persisting objects can appear to have dispositions.

Furthermore, because the colors we attribute to afterimages and the colors we attribute to physical objects

are phenomenologically indistinguishable, a red physical object also can't appear to have a disposition to look red. Thus, Boghossian and Velleman hold that a dispositionalist specification of the content of visual experience of color fails to provide a plausible description of color as we are conscious of it (1989, pp. 86-88).

Because it's difficult to understand what it means for something to appear to have a disposition in any case, it becomes clear that Boghossian and Velleman ignore a distinction required for a defensible dispositionalism. They ignore a distinction between a specification of the content of experience of color and a phenomenological description of color.

Drawing this distinction, the dispositionalist admits that afterimages appear red, but that in this context "appears red" is a phenomenological description. While the property red attributed to afterimages is phenomenologically indistinguishable from the red of physical objects, we can't immediately conclude that the property red attributed to afterimages is a disposition. To the contrary, the dispositionalist claims it is a color quale, namely, red'.

On the other hand, the dispositionalist can agree that an appearance of red is an appearance of a disposition to look red. But only so long as we don't take "appearance of red" and "appearance of a disposition to look red" to be phenomenological descriptions. Rather, the content of

visual experience includes red as a disposition of objects to produce visual experiences of red. We may understand "appearance of red" to refer to visual experiences themselves as the mental responses of the disposition. "Appearance of a disposition to look red" refers to the same visual experiences, a bit more verbosely.

Boghossian and Velleman's conflation of a specification of the content of visual experience of color and a phenomenological description of color provides the basis of their phenomenological objections. Thus against dispositionalism in general, they assume that by admitting that the perceptible quality red and the color quale red' are phenomenologically indistinguishable, one is committed to holding that these two types of properties have the same nature.

Against qualified dispositionalism, they assume that by specifying the content of visual experience of red in terms of red', one is thereby committed to holding that in visual experience we are conscious of red' as distinct from the perceptible quality red.

Rather than provide a refutation of dispositionalism, Boghossian and Velleman merely show that for this view to be tenable at all, its proponents must distinguish between a specification of the content of visual experience of color and a phenomenological description of color.

### 2.1.2.3. The Dispositionalist's Response

With the distinction between a phenomenological description of color and a specification of the content of visual experience of color clearly before us, we can see that Boghossian and Velleman's arguments miss their mark. They characterize content dispositionalism as holding that the property red is defined as a disposition to appear red under standard conditions.

The description "a disposition to appear red" refers to a disposition of physical objects to produce visual experiences of red. As Boghossian and Velleman point out, dispositionalists interpret this description in two ways because, according to their view, we may describe visual experiences of red in two ways.

We may describe visual experiences of red in terms of the property red of physical objects. In this case, we describe them in terms of their typical causes and in terms of the property we become aware of in virtue of having visual experiences of red.

Or, we may describe visual experiences of red in terms of red', that is, a conscious sensory quality of visual experience.

Dispositionalists do not offer a definition of visual experiences of red when they describe these states in terms of the perceptible quality red. Thus, for example, both McDowell and McGinn hold that visual experiences of red

provide us with awareness of properties of physical objects (McDowell, 1985, pp. 111-114; McGinn, 1983, pp. 5-9, pp. 130-137). But in this case, to describe visual experiences in terms of a perceptible quality is just to characterize them in terms of their typical causes and in terms of the property we become aware of in virtue of having them. McDowell and McGinn are not thereby committed to holding that visual experiences are defined in terms of perceptible qualities. They define visual experiences of red in terms of a color quale.

Also, by specifying the content of visual experience of red in terms of red', Peacocke does not commit himself to holding that a description of red as we're conscious of it in visual experience makes reference to red'. Rather, a phenomenological description merely refers to a property that satisfies the red'-involving definition of the property red, namely, a physical property of objects (Peacocke, 1984a, p. 415).

Boghossian and Velleman arrive at their division between dispositionalists by playing out two consequences of their conflation. As they claim, dispositionalists hold that the colors we are aware of in visual experience are properties of physical objects. Boghossian and Velleman formulate pure dispositionalism by taking the property red we are aware of in visual experience to define visual experience of red.

On the other hand, dispositionalists propose to define visual experience of red in terms of color qualia. Boghossian and Velleman formulate qualified dispositionalism by taking the property red', which defines visual experience of red, to be one we are aware of in visual experience. Due to their conflation, they make a false division between dispositionalists.

Furthermore, the dispositionalist can explain how the perceptible quality red and the color quale red' are phenomenologically indistinguishable despite their difference in nature. The colors of objects may be related in terms of qualitative similarity relations. For example, red is more similar to orange than blue. According to dispositionalism, perceptible qualities are relations between physical properties of objects and color qualia. Color qualia such as red' determine that we experience physical properties of objects as colors.

Thus, the qualitative similarity relations among red and the other colors of objects are wholly determined by the relations among red' and other color qualia. The qualitative similarity relations that hold among the colors of objects are identical to those that hold among color qualia. This identity between the two distinct ranges of properties explains why members of each range, for example, red and red', are phenomenologically indistinguishable.

(See, for example, Johnston [1992], who provides this

explanation. While Johnston proposes that physical colors are dispositions to produce visual experiences, he doesn't explicitly endorse qualia. Thus, it's not clear whether mental colors are qualia on his view. However, as I'll show in chapter 3, he goes on to argue that the qualitative similarity relations are an aspect of the nature of physical colors to which we have access in visual experience [1992, pp. 253-255].)

Boghossian and Velleman provide no basis for ignoring the distinction between a specification of the content of visual experience of color and a phenomenological description of color. They assume that our awareness of color in visual experience gives us access to the nature of color (1991, pp. 85-86). In this case, there is no distinction to be made between a description of the nature of color and a phenomenological description.

But then their dispute with dispositionalism is with respect to this assumption. Without arguing for this assumption, their conflation has the result of simply ruling out any tenable dispositionalism.<sup>6</sup> Thus, Boghossian and Velleman don't provide conclusive grounds on which to reject the dispositionalist's distinction between physical colors and color qualia.

---

<sup>6</sup> It is acceptance of the claim that awareness of color give us access to the nature of color which now leads McGinn to reject dispositionalism (1996, 539-540). McGinn also provides no argument for this claim.

In chapter 1, I reject color qualia, described as mental qualitative properties that are necessarily conscious. Thus, I deny that qualia are included in the contents of visual experience. I'll argue against dispositionalist proposals that hold that physical colors are relations between physical properties of objects and qualia in chapter 4.

However, I support the dispositionalist's distinction between physical color and mental color. Since Boghossian and Velleman do not establish that the colors we attribute to physical objects in visual experience are mental colors, they don't give us any reason to reject this distinction. But do we have reason to accept the distinction between physical color and mental color?

Next, I shall argue for this distinction, and thus give reasons to reject Boghossian and Velleman's proposal that colors are sensory qualities. From their proposal about the nature of color, no particular theory of color perception follows. But this proposal does impose a very strong constraint on a theory of color perception. For according to it, the colors that we perceive physical objects as having are mental colors.

The sense datum account proposed by Jackson (1977) holds that the colors we perceive physical objects as having are mental properties. Jackson claims that colors are properties of sense data, which are mental objects. I

believe that Jackson's account of color perception also faces serious problems, but I won't address Jackson's account here. (See Rosenthal, [1985] and [forthcoming], for compelling objections to Jackson's account. Jackson now denies that colors are properties of sense data [Jackson and Pargetter, 1987, p. 133, fn. 5].)

With the rejection of sense datum theory, the only alternative account of how we perceive physical objects as having mental colors is a projectivist theory of color perception. I'll examine Boghossian and Velleman's projectivist theory in the context of an alternative projectivist theory offered by McGilvray.

## 2.2. The Projectivist Theory of Color Perception

Informed by research on human color vision, McGilvray argues in "Constant Colors in the Head" (1994) that colors are not properties of mind-independent objects as they seem to be. Rather, he claims, as do Boghossian and Velleman, that colors are properties of visual experience. McGilvray takes the view that colors are neural events, and explains their properties in terms of properties of neural events (for convenience, I'll refer to colors on McGilvray's view as mental colors).

McGilvray reconciles this proposal about the nature of colors with our perceptual experience of colors as properties of mind-independent objects by offering a

projectivist account of color perception. Broadly characterized, projectivism holds that colors are sensory qualities that are experienced as properties of mind-independent objects. (Hardin, who also holds that colors are sensory qualities, takes note of problem of how mental colors are experienced as properties of mind-independent objects, but he doesn't address it [1993a, pp. 81-82].)

Although McGilvray is motivated to hold this counter-intuitive view of color perception on the basis of arguing that colors are sensory qualities,<sup>7</sup> a convincing case for projectivism requires explaining how projective representation of color works. If colors are sensory qualities, it seems that sensory qualities are experienced as properties of mind-independent objects. But how? If attempts at explanation face serious difficulties, then we have reason to reevaluate the motivating arguments for projectivism.

McGilvray directly addresses the problem of explaining projective representation of color. Although McGilvray proposes a version of projectivism that overcomes what he takes to be the primary objection to a projectivist account of color perception, I shall argue his account also faces serious objections. If McGilvray's determined attempt to solve the problem of explaining projection fails, we have

---

<sup>7</sup> I considered McGilvray's main argument for subjectivism in section 1.3.5.

reason to deny that the colors we perceive physical objects as having are mental colors and thus distinguish physical color and mental color.

McGilvray draws a distinction between two versions of projectivism, which provide different explanations for how it is that colors seem to be properties of mind-independent objects. According to one version, the colors we are aware of in visual experience are attributed to physical objects (pp. 225-227).<sup>8</sup> Since colors aren't properties of physical objects, color projection is systematically erroneous. But the sizes, shapes and locations we are aware of in visual experience are physical sizes, shapes and locations of physical objects. We correctly attribute the spatial properties we experience to physical objects.

This version seems to offer a simple explanation of color projection. Colors are experienced as properties of mind-independent objects just because colors are attributed to physical objects, which are independent of our minds. Furthermore, colors are attributed to physical objects because we are aware of colors along with properties such as shape and location. The physical spatial properties we visually experience physical objects as having are attributed to those objects, and colors are attributed to objects along with spatial properties.

---

<sup>8</sup> All citations are to McGilvray (1994) unless otherwise noted.

Although McGilvray doesn't refer to proponents of this version of projectivism, this is the view advanced by Boghossian and Velleman (1989), and Thomas Baldwin (1992). Following Boghossian and Velleman (1989, p. 96), I'll call this version traditional projectivism.

McGilvray proposes another version of projectivism. According to it, the colors we are aware of in visual experience aren't attributed to physical objects at all. He asserts that we are not directly aware of physical objects or any of their properties. McGilvray doesn't deny that there are physical objects, or that they have properties such as size, shape and location. But he claims the spatial properties as well as the colors we are aware of in visual experience are sensory qualities.

Thus, McGilvray attempts to explain how colors seem to be mind-independent properties without appealing to any direct awareness of physical objects or properties. He takes an altogether different approach. Rather than attempting to explain how projected colors seem to be properties of objects that are mind-independent, he attempts to explain how they are properties of objects that merely seem to be mind independent (pp. 210-213).

#### 2.2.1. An Argument against Traditional Projectivism

McGilvray motivates his version by arguing against traditional projectivism. The traditional view holds that

we are aware of mental colors in physical locations such as on the surfaces of physical objects. But if the traditional view is to provide an explanation of projection at all, it must explain precisely this claim. How are we aware of sensory qualities in physical locations?

Baldwin claims that although visually experienced locations are physical locations, physical locations are experienced by way of mental spatial properties, which he characterizes in terms of physical spatial properties (1992, p. 187). He also claims that mental spatial and color properties are necessary for visual experience (1992, p. 180). Baldwin asserts that because mental spatial properties provide awareness of physical spatial properties and such awareness is always accompanied by awareness of colors, mental spatial properties also play a role in making us aware of colors as located in physical space. In this way, mental color is experienced as ". . . the apparently objective quality of a physical object located before the subject" (1992, p. 185). (Hardin, 1993a, p. 82, p. 111, suggests a similar explanation.)

By relating mental colors and physical spatial properties by way of mental spatial properties, Baldwin's discussion goes some distance in explaining projective representation of color. But whether or not Baldwin's intriguing claims can be further developed, McGilvray provides an objection in principle to the very assertion

that mental colors can be experienced as having physical location.

McGilvray argues the traditional view ". . . assumes that we have independent access to physical surfaces, shapes, and the like, and somehow 'colorize' them" (p. 227) (emphasis in original). According to traditional projectivism, colors are experienced together with physical spatial properties. We may on this view describe visual experience of colors in terms of locating colors on physical surfaces or in terms of colorizing physical locations. On either description, it is difficult to understand how colors and physical spatial properties are visually experienced together (pp. 226-227).

This is because on traditional projectivism, the shapes and colors we visually experience are properties of fundamentally different types of things. For example, Boghossian and Velleman hold that colors attributed to physical objects may not be properties of objects at all. Rather, they are properties of the visual field which ". . . may or may not be describable by means of adverbs modifying mental verbs rather than by substantives denoting mental items" (1989, p. 96). Thus, their view of colors is consistent with an adverbialist theory of mental colors, according to which mental colors aren't properties of mental objects, in particular sense data, but rather are properties of mental events, states, or processes.

In this case, experiencing physical surfaces as colored involves representing physical objects as having properties of mental events, states, or processes. Since events, states, or processes are different sorts of things than objects, it's not clear that it even makes sense to hold that we experience physical objects as having properties of mental events, states, or processes.

(Shoemaker points out how "profoundly unattractive" it is to hold that "there is something like a category mistake, the attribution to things of features they could not have, involved in the content of every sense experience" [1990, p. 114] [emphasis in original]. Since Shoemaker doesn't indicate why physical objects and visual experiences can't have the same properties, he doesn't explicitly claim that they can't because events, states, or processes are different sort of things than objects.)

Rather than being objects, events, states, and processes are one or another sort of modification of objects. Thus events, states, and processes don't have the same sorts of properties as objects. For example, events, states, and processes don't have surfaces as objects have surfaces. Thus, it's not clear how we could experience the surfaces of physical objects as having properties of events, states, or processes. (Rosenthal, [1985], p. 37 and [forthcoming], makes these points about the contrast between objects and states.)

Boghossian and Velleman contend that there is no genuine problem associated with attributing properties of mental states to physical objects. They hold that we can imagine circumstances in which we would attribute pain to physical objects (1989, pp. 99-100). They claim, "[w]ere pain to be caused solely, say, by certain specific patches on the surfaces of plants, we might well experience pain as being in the plant, much as we now experience colour" (1989, p. 100).

But Boghossian and Velleman assume that if we were to attribute pain to physical objects, the pain we would attribute to objects would be the same property as the pain we do attribute to mental states. We would attribute a property of mental states to physical objects.

It is clearly open and it is more plausible to hold that in Boghossian and Velleman's imagined circumstances there would be a ambiguity in the word "pain". In one sense, "pain" would refer to a property of mental states; in another, this word would refer to a property of physical objects. In this case, the pain attributed to physical objects would be a property of physical objects, which typically causes the pain attributed to mental states. (See Paul Grice [1962] and L. C. Holborow [1969] for similar considerations that indicate "pain" would be ambiguous in Boghossian and Velleman's imagined circumstances.)

Thus, Boghossian and Velleman's consideration that

there could be circumstances in which we attribute pain to physical objects doesn't demonstrate that in such circumstances we would attribute properties of mental states to physical objects. They simply assume that if we were to use the word "pain" to describe physical objects we would thereby attribute a property of mental states to physical objects.

McGilvray offers an alternative version of projectivism that avoids the problem altogether. But, as I'll show, his solution faces a different formidable problem.

#### 2.2.2. McGilvray's Alternative Theory

McGilvray approaches the problem of explaining color projection by proposing that the colors we are aware of in visual experience are not attributed to physical objects at all. Rather colors are properties of two sorts of so-called objects which he defines for us: phenomenal objects and perceptual objects. Phenomenal objects are defined as complex neural events (pp. 211-212). The colors and spatial properties that we are aware of in visual experience are properties of these complex neural events (pp. 211-212, pp. 213-218).<sup>9</sup>

---

<sup>9</sup> To be precise, McGilvray holds that colors are neural events that in part constitute phenomenal events, complex neural events that are also in part constituted by mental spatial properties (pp. 211-212). He states, "[s]trictly speaking [colors are not] properties of phenomenal objects; color terms are sortals for neural events" (p. 212).

These neural events in turn are causally related to properties of physical objects. The colors of phenomenal objects are causally related to the surface reflectance properties of physical objects. The spatial properties of phenomenal objects are causally related to physical spatial properties such as the surface shapes of physical objects (pp. 213-217).

Perceptual objects aren't ordinary objects. McGilvray defines the perceptual objects of visual experience as colored patches that we are aware of in visual experience, and which we experience as external to our minds (p. 212, p. 219). But, McGilvray claims, nothing actually is colored and external to our minds. Since perceptual objects seem external, they are, he says, illusions. McGilvray claims, "[the perceptual object] combines incompatible properties (being colored and being outside) and does not exist; thus, it is an illusion" (p. 212).

Fundamental to McGilvray's view is a distinction between two sorts of content of visual experience of color, namely, referential intentional content and what he calls sensuous content. Referential intentional content includes physical objects and properties that cause and thus are detected by visual experience. The sensuous content of

---

This point noted, I'll continue to call the colors of visual experiences mental colors, which are properties of neural events, states, or processes.

visual experience includes the properties, such as colors, that we are aware of in visual experience.

Visual experience of physical objects is mediated by a relation to phenomenal objects. Due to the causal relations between the sensory qualities of phenomenal objects and physical properties of physical objects, properties of visual experience are reliable indicators of properties of physical objects. Perceptual objects are phenomenal objects described in terms of sensuous rather than referential intentional content (pp. 219-220, pp. 222-223).

By holding that the spatial properties as well as the colors of sensuous content are sensory qualities, McGilvray proposes a simple explanation of how colors are experienced along with spatial properties, even though colors aren't properties of physical objects. The colors and spatial properties we are aware of in visual experience are properties of the same phenomenal objects. When we experience these properties as external to our minds, they are properties of the same perceptual objects.

According to McGilvray, explaining color projection doesn't involve showing how sensory qualities are related to physical objects. On his view, this relation is merely causal. Rather, it involves explaining how sensory qualities are experienced as properties of seemingly mind-independent objects, or, as McGilvray puts it, how we experience colors as properties of perceptual objects.

### 2.2.3. Problems with McGilvray's Alternative Theory

McGilvray directly addresses the problem he sets up. He promises to explain how, by visual experience, "[we] get genuine colors 'in the head' out there and 'onto' external objects" (p. 209).

He points out how some aspects of our experience of colors are explained in terms of sensory qualities. As McGilvray claims, Clark (1993) shows how qualitative similarity relations can be explained in terms of properties of neural events, states, or processes (pp. 213-215).

But is it plausible that the experience of an object as mind independent can be explained in the same way? McGilvray urges us to think of visually experiencing objects as mind independent in terms of experiencing them as external to our minds (pp. 225-226). But if the locations we experience objects to be in aren't physical locations, then, as McGilvray claims, they are mental locations.

McGilvray's approach to explaining color projection becomes at least initially plausible by being clear about an ambiguity in the term "external." In one sense of "external," objects are experienced as external to our minds if, assuming that our minds are in our heads, they are experienced as in some location distinct from where our heads are. McGilvray tries to capture this sense of "external" by appeal to a mapping of mental locations of a three-dimensional visual field (pp. 214-215).

In another sense of "external," objects are external to our minds if they exist independently of our minds. Clearly this sense of "external" isn't captured in terms of mental locations of a visual field.

McGilvray claims that in the context of describing our experience of perceptual objects as external to our minds, we use the term "external" in only the first sense. He describes perceptual objects as colored patches located in a three-dimensional visual field. Since perceptual objects aren't ordinary objects, we needn't suppose that we attribute mind-independent existence to them. McGilvray claims that attributions of mind-independent existence aren't made by experiential states at all, but rather by beliefs. When we say that there are colored objects that exist independently of our minds, we are expressing a belief about ordinary objects such as tables and chairs rather than describing an experience of perceptual objects (pp. 228-230).

McGilvray may be correct to hold that attributions of mind-independent existence are made by beliefs. But McGilvray's approach to explaining projection is successful only if we accept that the spatial properties we experience are only properties of the visual field. As Baldwin (1992, p. 184) claims, it's far from clear that we should.

Mental spatial properties, as neural properties, have locations. But we are not aware of these locations in our

experience of objects. Furthermore, McGilvray's three-dimensional mapping of mental locations allows us to characterize locations distinct from where our heads are only with respect to other such locations. It doesn't allow us to characterize the whole system of such locations with respect to our heads.

Since McGilvray holds that the objects we do experience, perceptual objects, don't exist, he simply avoids the question of how we are to characterize the locations we experience as distinct from where our heads are with relation to our physical heads. By claiming that the spatial properties we experience are only sensory qualities, McGilvray renders experienced locations mysterious.

But if there are mental spatial properties then, as Baldwin proposes, these properties play a role in providing us with awareness of physical spatial properties. We can then characterize mental spatial properties in terms of the physical properties they provide us awareness of.

In this case, the spatial properties we are aware of in visual experience are properties of physical objects, not mental spatial properties of the visual field. Rather than accept experience of mysterious locations, we must conclude that the spatial properties we perceptually experience aren't sensory qualities, but instead are properties physically external to our minds and exist independently of them.

McGilvray's own terminology supports this conclusion. As an illustration, by describing perceptual objects as illusions (p. 212, p. 219), McGilvray suggests thinking of perceptual objects as somehow analogous to physical objects. For in the context of describing perceptual states, the word "illusion" usually applies to a case of misattribution of properties to an existing physical object. It seems McGilvray uses the word "illusion" to describe perceptual objects because he claims that in experiencing perceptual objects we wrongly experience them as having locations outside of our heads.

But in this case, using the word "illusion" to describe what is experienced is misleading. If McGilvray were to describe perceptual objects as hallucinations, the difficulty with accepting that the spatial locations we experience are only properties of the visual field would be more transparent.

Also, McGilvray's use of the term "object" in his expression "perceptual object" is similarly misleading. It distracts us from fully appreciating the proposal that experienced spatial properties are never physical spatial properties.

Moreover, McGilvray's promised explanation of color projection in terms of properties of neural events doesn't help us address concerns about accepting this proposal. He claims that neurophysiological evidence supports his

projectivist view. In particular, McGilvray cites evidence that properties of neural events play a role in explaining the visual effect called color constancy (pp. 217-218).

Color constancy is the visual effect in which the color a physical object looks remains fairly constant despite differences in the intensity or wavelength composition of the light illuminating the object (Boynton, 1979, p. 26). Properties of neural events that operate independently of belief or inference play a role in explaining color constancy (p. 218). (Boynton, 1979, pp. 183-185; Hurvich, 1981, pp. 199-200 also make this claim.) Because McGilvray holds that the objects we experience are perceptual objects, he claims that color constancy indicates that "the perceptual object is largely an automatic construction of the visual system" (p. 226).

Even if properties of neural events play a role in explaining aspects of visual perception, for example color constancy, the colors and spatial properties we are aware of in visual experience need not be sensory qualities. Theorists who hold that colors are properties of physical objects would contend that color constancy indicates the colors we are aware of in visual experience of physical objects are reflectance properties of their surfaces. For it is surface reflectance properties that remain constant despite differences in illumination. (See, for example, Hilbert (1987) and Mohan Matthen (1988), who argue that

colors are properties of physical objects on the basis of color constancy.)

Indeed, McGilvray independently argues that colors are sensory qualities (pp. 200-209). While McGilvray shows that subjectivism is consistent with neurophysiological accounts of color constancy, such accounts provide no evidence for color projection. He merely infers that if colors are sensory qualities then neural events, such as those involved in color constancy, explain color projection.

While there may be properties of neural events that we can call mental spatial properties due to their role in visual experience, McGilvray doesn't provide neurophysiological support for believing it's these mental properties we are aware of in visual experience. Rather the only support he provides for this claim is that colors are sensory qualities. Furthermore, accepting any neurophysiological explanation of projection requires that we accept the proposed explanandum, namely, that the spatial locations we experience are only sensory qualities. As I've argued, it's not clear that we should.

McGilvray is careful to distinguish his account of color perception from the account offered by sense datum theory (p. 227). Even so, his account has in common with the sense datum theory a serious problem in explaining the relation between perceivers and the objects they experience. According to Jackson's sense datum theory, visual experience

is a relation between perceivers and sense data, which are mental objects located in physical space (1977, pp. 102-103). However, Jackson provides no account of this relation.

This problem also arises for those, for example, Charles Landesman (1989), who hold that colors exist, but are uninstantiated universals. Landesman allows that colors appear to us, and that we're aware of qualitative similarity relations among colors (p. 106). But it's not clear how perceivers can be related to uninstantiated universals such that we can be aware of relations among uninstantiated universals. For it's not clear how we can be related to uninstantiated universals such that they appear any way at all.

On McGilvray's account, visual experience is a relation between perceivers and so-called perceptual objects. Although McGilvray asserts that perceptual objects are automatic constructions of our visual systems, this is no explanation. He merely trades the mental magic that relates perceivers and sense data for neurophysiological magic that relates perceivers and so-called perceptual objects.

With no explanation of how color projection works, however, the notion of color projection is left as a metaphor. The term "projection" has a clear sense when we say that we project our emotions onto others. But other people have emotions, even if not the ones projected; the

attribution is unproblematic. Projective representation of colors faces difficulties because it's motivated by the very claim that colors are sensory qualities and thus that no mind-independent objects have colors. I've argued that these difficulties may be insurmountable.

If problems with explaining projective representation of color can't be overcome, we have reason to reject the motivating claim for projectivism, namely, the claim that colors are sensory qualities. For, with the rejection of sense datum theory, the only alternative account of how we perceive physical objects as having mental colors is a projectivist theory of color perception. The only tenable accounts of color perception hold that the colors we perceive physical objects as having are physical colors. Thus, we thus have reason to distinguish physical color and mental color.

### 2.3. Two Distinct Ranges of Colors

I've attempted to refute the claim that the colors we perceptually experience physical objects as having are sensory qualities. To this end, I've considered and rejected empirical, epistemological, and phenomenological arguments for subjectivism.

Also, I've raised a problem in principle for any subjectivist proposal about the nature of color. Subjectivism about the nature of color must be combined with

some explanation of how colors are experienced as properties of mind-independent objects. I've argued that no projectivist account is workable. Since no alternative accounts of color perception are offered by subjectivists, this argument provides a compelling reason to reject any subjectivist proposal. Furthermore, it provides a compelling reason to reject Boghossian and Velleman's strong version of the epistemological constraint. According to this version of the constraint, ordinary visual experience provides sufficient access to the nature of color such that we can simply rule out physicalist and dispositionalist proposals about the nature of physical color.

With the rejection of projectivism, I conclude that physical colors are needed to explain our perceptual experience of physical objects as colored. In this case, color terms are ambiguous as between their application to properties of visual experiences and their application to properties of physical objects. I'll now turn to the issues of how to describe physical colors and how to characterize the relation between physical colors and mental colors.

### 3. Johnston's Dispositionalism

In his ingenious and fertile article "How To Speak of the Colors" (1992), Johnston approaches the question of the nature of the colors we attribute to physical objects by considering our concept of color.<sup>1</sup> On Johnston's view, the concept of a property is a cluster of core (de dicto) beliefs about the property. Core beliefs about a property are beliefs such that "were such beliefs to turn out not to be true we would then have trouble saying what they were false of . . ." (p. 221).<sup>2</sup>

Thus on Johnston's approach, the first task is to determine what beliefs about the colors we attribute to physical objects are core. I'll give Johnston's list of core beliefs, and consider his arguments for this list.

Johnston then puts forward a proposal about the nature of color, tailored to agree with his list of core beliefs. He claims that the colors we attribute to physical objects are dispositions of objects to bring about particular perceptual responses.

---

<sup>1</sup> A good bit of the argument for dispositionalism presented in "How To Speak of the Colors" is also presented in "Is the External World Invisible?" (1996a). However, in the latter article, Johnston presents doubts about dispositionalism (pp. 197-198). I'll note these below.

<sup>2</sup> All citations in this chapter are to Johnston (1992) unless otherwise noted.

I'll examine his dispositionalist proposal, and show how it agrees with the beliefs he holds to be core. In this discussion, I'll make clear ways in which Johnston holds that the colors of objects are mind dependent and ways in which they are mind independent.

I'll then take up Johnston's argument for dispositionalism. He claims that only dispositionalism agrees with the beliefs he holds to be core. Finally, I'll show that Johnston's argument relies on accepting as core a belief about color which is actually highly contentious. Johnston's argument ultimately fails because he doesn't successfully argue for his list of core beliefs.

### 3.1 Core Beliefs about Colors

Johnston offers the following claims as candidates for core beliefs about color:

- Paradigms: some objects that we take to be paradigms of vivid red (for example, some strawberries) are vivid red.
- Explanation: the vivid redness of objects sometimes causally explains our visual experiences that objects are vivid red.
- Unity: vivid red occupies a place in the color space, a three-dimensional space with dimensions of hue, saturation and lightness. The color space represents the qualitative similarity relations among colors.

- Perceptual availability of colors of objects:

knowledge of whether a physical object is vivid red is perceptually available. That is, a belief that an object is vivid red is justified simply ". . . on the basis of visual perception and the beliefs which typically inform it" (p. 222) The latter beliefs are ". . . general background beliefs about the external causes of visual experience which inform ordinary perception" (p. 223).

- Revelation: "[t]he intrinsic nature of [vivid redness] is fully revealed by a standard visual experience as of a [vivid red] thing" (p. 223).

Johnston further describes Revelation as equivalent to Russell's doctrine of acquaintance with regard to colors (p. 223). He quotes Russell on acquaintance:

. . . so far as concerns knowledge of the colour itself, as opposed to knowledge of truths about it, I know the colour perfectly and completely when I see it, and no further knowledge of it itself is even theoretically possible (p. 223, quoting Russell, 1912, p. 47).

If we know colors by acquaintance, then colors are nonrelational properties of objects, as they seem in visual experience.

But Johnston points out that this provisional list cannot be correct. As they are stated, Explanation and Revelation cannot both be true. According to Explanation, the colors we attribute to physical objects are properties of objects. In this case, the nature of color is not fully

revealed in visual experience.

For if physical objects have colors, these properties will either be physical properties of objects, or relations of physical properties of objects to our perceptual responses, namely, visual experiences of color. Visual experience reveals neither that the colors we attribute to objects are physical, nor that they are relations of physical properties to visual experiences of color (pp. 224-225).

One can avoid the conflict between Explanation and Revelation by simply rejecting one of these claims. One may reject Explanation, and hold that physical objects aren't colored. The vivid redness we experience is not a physical property of physical objects which causally explains our experience. Rather, it is a property of visual experience itself. Subjectivists such as Boghossian and Velleman reject Explanation (p. 228).

Or, one may reject Revelation, and hold that the colors of physical objects are physical properties which aren't revealed at all in visual experience. Physicalists such as Armstrong reject Revelation.

Johnston claims that, although the original list cannot be accepted, neither Explanation nor Revelation should be altogether rejected. He argues that the best proposal is to modify Revelation, and accept Explanation as it is stated (p. 223).

Johnston modifies Revelation to hold that, while the nature of color is not fully revealed in visual experience, some aspects of the nature of color are revealed in visual experience. In particular, Johnston holds that the qualitative similarity relations referred to in Unity are an aspect of the nature of color which is revealed in visual experience.

Johnston's modification of Revelation is:

If you know or are acquainted with the nature of properties  $F_1, F_2, \dots, F_N$  then you can know a family of similarity and difference relations (unity principles) holding among  $F_1$  through  $F_N$  and know these without relying upon knowledge of the laws in which the properties are implicated or upon knowledge of which particulars have the properties (p. 254).

Along with Johnston's modified Revelation comes a modified notion of acquaintance. I shall use the term "acquaintance" in only this modified sense.

Thus, Johnston holds a weak version of what I call the epistemological constraint on the nature of color. According to this weak version, visual experience provides access to only an aspect of the nature of color.

If the nature of color is not fully revealed in visual experience, then it may be that the colors we attribute to objects are properties of objects. For example, it may be that the colors of objects are--as is not revealed in visual experience--dispositions of objects to produce visual experiences of color. At the same time, according to modified Revelation, the Unity principles set out an aspect

of the nature of color which is revealed in visual experience.

Why accept Explanation, the claim that the colors we attribute to objects are properties of objects, which causally explain our visual experiences of color? Why not agree with Boghossian and Velleman and hold that the colors we attribute to objects are mental properties?

As Johnston states, the conflict between (unmodified) Revelation and the dispositionalist proposal is that the colors we attribute to objects don't look like dispositions in visual experience. They should look like dispositions, if the dispositionalism is true and visual experience reveals the nature of the colors we attribute to objects.

Against Boghossian and Velleman's claim that the colors of objects cannot be dispositions because they do not look like dispositions, Johnston holds that this claim relies on what he calls a projective error. According to Johnston's notion, projection involves mistakenly believing that our awareness of color fully reveals the nature of color. On this notion, projection doesn't involve mistakenly attributing mental colors to physical objects. It doesn't involve mistakenly attributing mental properties at all. Rather, it involves having mistaken beliefs about colors due to naively accepting Revelation.

Moreover, Johnston holds that the mistaken beliefs about colors which result from naively accepting Revelation

should simply be rejected. Accordingly, Johnston modifies Revelation. He claims we should distinguish between a description of color as we are conscious of it in visual experience and a specification of the nature of color (pp. 224-228; 1993, pp. 106-109).

In another argument against the view that the colors we attribute to physical objects are properties of visual experiences, Johnston claims that Explanation is a plausible requirement for physical objects being visible (p. 259, fn. 1, p. 260, fn. 12, p. 254). He asserts that physical objects are visible only if we are acquainted with them, and that to be acquainted with objects, we must be acquainted with their properties. Furthermore, we are acquainted with properties if we have access to the natures of properties as according to modified Revelation (pp. 254-255).

Thus, acquaintance with objects requires that colors are properties of objects. But then it's a plausible requirement for acquaintance with the colors of objects that colors causally explain our visual experiences of color (pp. 254-255, p. 259, fn. 1).

Johnston's argument for Explanation appeals to modified Revelation. Johnston argues for modified Revelation by holding that we should value acquaintance with colors, and thus we should accept a proposal about the nature of color that is consistent with acquaintance with colors (pp. 254-259). He states, "[p]erception represents itself as (or is

at least spontaneously taken by its possessors as) a mode of access to the natures of things" (p. 257).

Johnston asserts that if perception doesn't at all reveal the natures of the properties of physical objects, including their colors, then we might have the following skeptical worries. When we take ourselves to be perceiving mind-independent objects that make up a landscape and which have various colors and shapes, are the objects truly there? Or might it be the case that we are brains in vats merely undergoing neural stimulation that creates the hallucination that we are perceiving objects that make up a landscape?

Johnston holds that unless visual experience reveals the natures of properties of physical objects, there's simply no way of ruling out the latter possibility. Thus, he claims that to calm skeptical worries, we should accept that we are acquainted with the natures of the properties of physical objects, including their colors. Since we value calming skeptical worries, we should value acquaintance, and accept a proposal about the nature of color that is consistent with it (pp. 257-259).

Johnston's arguments for modified Revelation provide crucial support for his dispositionalist proposal about the nature of physical colors. I'll criticize his argument for modified Revelation in the context of his argument for dispositionalism.

Having argued for Explanation and modified Revelation,

Johnston holds that Paradigms, Explanation, Unity, Perceptual Availability, and modified Revelation are core beliefs about colors. Competing proposals for the nature of physical colors can be evaluated with regard to how well they agree with these core beliefs. Next, I shall examine Johnston's proposal for the nature of physical colors, and show how it agrees with these core beliefs.

### 3.2. Physical Colors

Johnston claims that colors are dispositional properties on the basis of arguing that our color concepts are what he calls response-dispositional concepts. This argument involves defining response-dispositional concepts, and showing that the cluster of core beliefs that constitutes response-dispositional concepts best fits the cluster of core beliefs that Johnston claims constitutes color concepts.

I'll give his definition of response-dispositional concepts, and show that the cluster of core beliefs that constitutes these concepts matches Johnston's proposed cluster of core beliefs about colors. Before discussing his argument for dispositionalism, I'll examine Johnston's detailed description of colors as response dispositions.

Johnston defines a response-dispositional concept to be a concept of a disposition to produce a mental response in a specified subject (or group of subjects) in specified

conditions (pp. 229-230). Thus, Johnston proposes that our concept of vivid red is the concept of a disposition of physical objects to look vivid red to specified perceivers in specified viewing conditions. Johnston further holds that our concept of vivid red is of what he calls a constituted response disposition. A constituted disposition is one that is realized by some physical property or other (1992, p. 234).

Much of Johnston's list of core beliefs about colors falls right out of the definition of a response-dispositional concept. Concepts of constituted response dispositions are concepts of physical properties of objects that causally explain particular mental responses. Thus, as concepts of constituted response dispositions, color concepts agree with Paradigms and Explanation.

Also, since concepts of constituted response dispositions are concepts of properties that cause a particular mental response, are typically justified in believing, simply on the basis of the mental response, that an object has the dispositional property. Thus, as concepts of constituted response dispositions, color concepts agree with Perceptual Availability.

Although Johnston doesn't define response-dispositional concepts in terms of acquaintance, he claims that subjects are, by way of the mental responses produced by response dispositions, acquainted with the nature of response

dispositions (pp. 254-255; 1993, p. 104). With respect to color, Johnston holds that acquaintance is revelation in visual experience of an aspect of the nature of color, in particular, the qualitative similarity relations referred to in Unity (pp. 254-255). By claiming that subjects are acquainted with response dispositions, Johnston shows that color concepts, as concepts of constituted response dispositions, agree with modified Revelation and Unity.

Johnston explains acquaintance with response dispositions by holding that the mental responses produced by response dispositions provide at least partial access to the nature of response dispositions. Johnston claims:

When a disposition is a disposition to produce a certain subjective response then a subjective response of the kind in question may indeed reveal the nature of the disposition so long as the subject takes his response to be the manifestation of that disposition (p. 226).

Since the mental response is subjective, and this response in part constitutes the dispositional property itself, awareness of the response provides access to the nature of the disposition. (Johnston [1992] isn't explicit about his meaning of "subjective response." In conversation, he admitted that one idea he had in mind was that experiences have qualia.)

Johnston draws the distinction between response-dispositional concepts and other concepts in terms of acquaintance, where acquaintance with a property requires

that its nature be at least partially revealed by a mental response.

Thus, water is not a response dispositional property because we do not have access to the nature of water through our mental responses. Although water is stuff that seems colorless, odorless, and tasteless, these mental responses, namely, seeming colorless, odorless, and tasteless, don't provide access to the nature of water (1993, pp. 104-105).

With this account of concepts of response dispositions as properties in part constituted by our mental responses, Johnston shows a way in which response dispositions can be said to be mind dependent. As response dispositions, colors are in part constituted by our mental responses, namely, visual experiences of color. By further characterizing physical colors, Johnston makes clear the sense in which physical colors are mind dependent, and the sense in which they are mind independent.

Before focusing on Johnston's subtle description of physical color, I will briefly consider his relatively underdeveloped description of the mental relatum of physical color, namely, visual experiences of color.

### 3.2.1. Visual Experiences of Color

Johnston characterizes visual experiences of color as mental states caused by physical colors (1989, p. 147). Because he holds that physical colors are dispositions to

produce visual experiences of color, and he provides no description of visual experiences of color which is independent of physical color, he seems vulnerable to the objection that his characterization is circular.

Johnston discusses visual experiences of color primarily from the standpoint of addressing the issue of circularity. He distinguishes between circularity that would render his description of visual experiences of color empty and circularity that simply involves stating our knowledge of visual experiences in terms of physical colors. He cautions to avoid the former circularity, and holds that the latter presents no difficulties.

Having proposed that physical colors are dispositions to produce visual experiences of red, a characterization of a visual experience of red as simply 'the red-detecting response, whatever that is' would be empty (pp. 229-230; 1989, p. 145). Johnston holds that such a characterization wouldn't demonstrate knowledge of visual experiences of red. Rather, we must provide a "substantial or nontrivializing" description of mental responses (1989, p. 145). Johnston describes visual experiences of red in terms of physical red.

Johnston admits that the combination of his dispositional account of physical red, and his characterization of visual experiences of red in terms of physical red is in a sense circular. Physical red is held

to be a relation between a physical property and visual experiences of red, and visual experiences of red are in turn characterized in terms of physical red. But this characterization of visual experiences of red is a statement of our ordinary knowledge of these mental states. Our ordinary knowledge of visual experiences of red is stated in terms of the physical cause of those states, namely, physical red.

As Boghossian and Velleman argue, if Johnston were to define visual experiences of red in terms of physical red, then he would be vulnerable to a vicious regress (Boghossian and Velleman, 1989, pp. 88-91). Dispositionalism isn't compatible with defining visual experiences of color in terms of physical colors. But Johnston holds that visual experiences of red are not to be defined in terms of physical red (1987, p. 147; 1993, pp. 105-106, 118-119). (See section 2.1.2.3. for a general dispositionalist response to Boghossian and Velleman's argument.)

Johnston doesn't describe visual experiences of red aside from characterizing them in terms of physical red. Rather than focus on providing a fuller description of visual experience of color, Johnston focuses on giving a detailed description of physical color. He does this by specifying the complex relation that constitutes physical color, that is, the relation between some range of physical

properties of objects and the range of visual experiences of color.

### 3.2.2. Specifying Physical Colors

Johnston proposes that physical colors are dispositional relations between physical properties of objects and visual experiences of color. The subtlety of Johnston's description of physical colors isn't to be found in his description of either relatum of this relation. The physical property relatum is whatever physical property is appropriately related to visual experiences of color, and, as I've just noted, visual experiences of color are not fully described.

Rather, it is Johnston's description of the relation itself which is discerning. Johnston lays out which relations are the physical colors, given variable perceivers, viewing conditions, and mediating processes. (Mediating processes are processes such as passage of light through air, which are necessary for physical properties of objects to produce visual experiences of color.) Thus, these considerations demonstrate ways in which physical colors are relative to perceivers, viewing conditions, and mediating processes.

Having described various ways in which physical colors are relative, Johnston argues that such relativity is compatible with a distinction between real and illusory

colors. Also, because he holds that the relation between physical properties of objects and visual experiences can be merely counterfactual, Johnston's proposal about the nature of physical color allows that physical colors are, in a sense, mind independent.

### 3.2.2.1. The Relativity of Physical Colors

Johnston proposes that physical vivid red be described as the constituted dispositions to look vivid red relative to specified perceivers in specified viewing conditions (pp. 229-231, p. 234, p. 248). Furthermore, he holds that such dispositions are standardly mediated dispositions (pp. 243-247).

Johnston pays particular attention to two aspects of a description of physical colors in terms of specification of perceivers, viewing conditions, and mediating processes: precision and what he calls rigidification.

Johnston's description of physical colors allows precise or vague characterizations of perceivers and viewing conditions. He admits that these characterizations are often put in terms of what's standard or typical, and that what's standard or typical can be vague.

Standard viewing conditions can be described as viewing conditions that involve daylight or ordinary indoor light. This notion of standard viewing conditions reflects the way we normally talk about the colors of objects (pp. 247-248).

However, more precise descriptions of viewing conditions might be required in some cases, for example, in psychophysics experiments. Johnston's description of physical colors in terms of specified viewing conditions allows for the additional precision.

Standard or typical perceivers can be described in terms that are fairly precise. Standard human perceivers are perceivers that have the most common human visual systems, namely, nonanomalous trichromats. However, what is the most common human visual system could change.

Physical colors are rigidified if we describe them in terms of standard perceivers and standard viewing conditions as these perceivers and conditions actually are (p. 243). Describing physical red this way relativizes physical red to nonanomalous trichromats. Rigidification allows us to hold that an object would be physical red even if human visual systems were to change such that there were no longer any nonanomalous trichromats.

Furthermore, differences in visual systems can produce differences in the colors that physical objects look. Thus, rigidification allows us to hold that an object would be physical red, even though, due to changes in human visual systems, it would no longer look red to anyone. The object would be physical red because it would look red to a nonanomalous trichromat.

Alternatively, the characterization of standard

perceivers needn't relativize physical colors to actual standard perceivers, or any particular type of human perceiver. Physical red could be described with relation to whatever human perceivers are standard or typical, however it is that their visual systems work.

In this case, if human visual systems change such that objects that had looked red no longer look red to the standard perceiver, objects that were physical red are physical red no longer. Physical red--the property attributed to objects by their looking red--changes relative to changes in standard perceivers. (See Jackson and Pargetter, 1987, pp. 131-137, for a description of physical colors along these lines.)

With regard to the mediating processes of dispositions, what Johnston calls a standardly mediated disposition is simply a disposition relativized to standard mediating processes. A standardly mediated disposition is one for which ". . . there is some standard process or processes mediating between the dispositions to appear colored and their effects, viz., the various color appearances" (1992, p. 242). An example of such a standard mediating process is the passage of light reflected by opaque surfaces to the eye through transparent volumes, for example, of air (1992, pp. 243-249).

As with a specification of perceivers and viewing conditions, we can be more or less precise in a

specification of mediating processes (p. 244). Also, what is standard with respect to mediation processes can change (pp. 247-248).

Johnston points out that four-color printing is currently a common technology for printing colored images in magazines. With four-color printing, colored images of any shade at normal reading distance are made up of small dots of only four shades. This visual effect is called additive color mixing.

Additive color mixture is produced when the same part of the retina is stimulated by colored objects or light of different colors. In the case of magazine images, the differently colored dots are too close together to be seen separately from normal reading distance. Thus, the same part of the retina is stimulated by differently colored dots, producing an additive mixture. With magazine images, additive mixing can also be easily circumvented by bringing the image close to the eye.

Seeing on close inspection that colored magazine images are made up of small dots of only four colors, should we conclude that such colored images only have four colors? Johnston holds that we determine the answer in part by determining whether the additive color mixing is a standard mediating process.

Considering the pervasiveness of four-color printing, we might decide that additive color mixing is a standard

mediating process. If we also hold that the colors of magazine images are the colors such images look from normal reading distance (a qualification on viewing conditions), then magazine images have more than four colors (pp. 246-248).

(Johnston holds that the so-called subjective colors produced by a Benham disk are an example of colors produced by a nonstandard mediating process. See section 1.3.4.1.2. for a description of Benham disks.)

So far, the discussion of the relativity of physical colors to viewing conditions, perceivers, and mediating processes has served merely to introduce the dimensions along which physical colors are specified. Perceivers, viewing conditions, and mediating processes can be specified vaguely or precisely. Furthermore, physical colors can be rigidified by describing them in terms of actual specified perceivers, viewing conditions, and mediating processes.

According to some theorists, for example, Hardin (1993a, pp. 67-82), since dispositionalism relativizes the colors we attribute to physical objects to perceivers, viewing conditions, and mediating processes, this view cannot provide an adequate characterization of the nature of these colors. For there's no principled way of specifying perceivers, viewing conditions, and mediating processes.

Next, I'll describe this argument against dispositionalism more fully, and consider Johnston's response.

#### 3.2.2.2. Setting Standards and the Distinction between Real and Illusory Colors

It's obvious that the color a physical object looks depends on the context in which the object is seen. Hardin argues that it is difficult to reconcile this fact with the claim that the colors attributed to physical objects are dispositional properties of objects to produce visual experiences of color (1993a, pp. 67-82; 1990, pp. 562-564).

Hardin argues as follows. If one holds that colors are physical properties of objects, one must accept that our perceptual states don't always represent these properties correctly. Thus, one must accept that there is a distinction between perceptual states that attribute to objects their real colors, and perceptual states that attribute merely illusory colors.

Also, if one holds that colors are physical properties, one must hold that the distinction between the real and the illusory colors of objects must be based on physical differences. Furthermore, the claim that a physical property is the real color of an object must be based on scientific principle (1993a, p. 81; 1990, p. 555-556, pp. 562-564; see also Thompson, 1995a, pp. 118-120, p. 246, who refers to Hardin's argument).

But an object that looks red in daylight doesn't look red under a mercury-vapor lamp. There is a physical difference between daylight illumination and the illumination produced by a mercury-vapor lamp, but the claim that the object is really red cannot be based on scientific principle. Favoring daylight illumination to that produced by a mercury-vapor lamp to determine the real colors of objects is just arbitrary. Moreover, any specification of perceivers and viewing conditions would be relative to our interests and thus wouldn't be grounded on scientific principle (Hardin, 1990, p. 562).

This argument assumes that a distinction between real and illusory color should be grounded on scientific principle. Colors are called illusory for different reasons. One of the most familiar reasons that we say that a color is illusory is because the illumination is unusual. A red object only looks brown under a mercury-vapor lamp.

However, this way of talking need not be based on a scientific distinction between real and illusory colors. That objects are the colors they look in daylight isn't a scientific result. The distinction between real and illusory colors which this usage indicates is based on linguistic convention.

For the most part, the reference of "vivid red" as applied to physical objects is relativized to standard or typical perceivers and viewing conditions. Thus, Johnston

proposes a distinction between real and illusory colors by relativizing real colors to standard or typical perceivers and viewing conditions (pp. 247-248).

In this case, illusory colors are perceived physical properties of objects deemed nonveridical due to a conventional and interest-relative account of the application of color terms. If our conventions and interests change, for example, if illumination by mercury-vapor light becomes standard, colors that had been illusory would become real.

Since seeing objects in daylight or ordinary indoor light is standard, we say that we see the real colors of objects in daylight or ordinary indoor light (pp. 247-248). There are cases where standard viewing conditions are too vague to determine what color to call an object. For example, given changes in illumination, the sea might look green, blue, or grey. Standard viewing conditions don't allow us to determine its real color (p. 248).

Ordinarily, physical colors can be relativized to standard perceivers, viewing conditions, and mediating processes. Since what standard perceivers, viewing conditions, and mediating processes are may be vague, descriptions of physical colors may be vague. In addressing a particular problem, we can add precision. For example, if we want to determine the conditions in which perceivers experience unique green, a green that is not at all

yellowish or bluish, we can precisely measure experience of hue in experimental conditions.

Johnston's view allows this additional precision. He claims that the issue of how precise perceivers and viewing conditions are to be described can be settled by our interests in describing physical colors.

However, our ordinary color terms aren't precise. They apply to a range of subtly different shades. As Clark nicely puts it, our ordinary color terms don't refer to points in the psychological color space, but rather regions (1993, p. 192). (See Armstrong, 1969, pp. 115-117; Smart, 1987, pp. 175-176; Jackson and Pargetter, 1987, pp. 134-135; and Lewis, forthcoming, pp. 4-5, for similar views about standard perceivers and viewing conditions.)

With respect to a distinction between real and illusory color, Johnston and Hardin are simply concerned with different notions of real colors. According to Johnston's notion, the correct attribution of colors to physical objects is determined by our ordinary usage of color terms. His characterization of real colors lays out the conditions in which we would say that something that looks red is red, and the term "red" is correctly applied. Hardin demands a scientific notion of real color. According to Hardin, the correct attribution of colors to physical objects must be determined by scientific principles.

Thus, Johnston's notion of real color doesn't meet Hardin's constraint that it be a scientifically principled notion. In the next section, I shall evaluate Hardin's constraint.

### 3.2.2.3. Physical Colors and Nonphysical Categories

The issue of the correct attribution of color to physical objects is ambiguous between the following two issues. First, what is the nature of the colors we attribute to physical objects, that is, are they physical properties, mental properties, or a relation between physical properties and mental properties?

Second, since the colors attributed to physical objects vary according to perceivers, viewing conditions, and mediating processes, relative to which perceivers, viewing conditions, and mediating processes do we attribute colors to physical objects?

Why believe that the relativity of color provides considerations which determine the issue of the nature of the colors we attribute to physical objects?

Hardin suggests that the underlying problem with specifying colors in terms of standard perceivers and standard viewing conditions is that, unlike the shapes of objects, in the case of colors, ". . . there is no . . . single, purpose-free procedure" for attributing colors to physical objects. Therefore, ". . . we are not entitled to

say that physical objects have determinate colors simpliciter" (1993a, p. 81). However, physical objects have shapes simpliciter (1993a, p. 112).

Thus, Hardin assumes that the only tenable distinction between real and illusory color would be a principled physical distinction. But since physical color categories--the categories by which we classify physical colors as the same or different and similar or dissimilar--aren't physical categories, there isn't a principled physical distinction between real and illusory physical color. Since physical color categories aren't physical categories, there's no way of classifying a physical object by color independently of the color categories of the visual system of some perceiver.

By contrast, since shape categories--that is, the categories by which we classify shapes as same or different and similar or dissimilar--are physical categories, there is a principled physical distinction between real and illusory shape.

But this difference between physical color and physical shape is due to the fact that physical color categories are importantly determined by our visual systems, and physical shape categories aren't determined by our visual systems, or the systems of any other single perceptual modality.

Thus, Hardin's constraint that there be a scientifically principled distinction between real and illusory color, and thus a scientifically principled notion

of real color, boils down to the assertion that physical color categories must be physical categories.

Moreover, this assertion assumes the metaphysical constraint. According to the metaphysical constraint, no range of properties can be identified with colors unless members of the range of properties are intrinsically related in ways that correspond with the qualitative relations we're aware of in ordinary experience. Thus, if physical properties are colors, then physical properties must be intrinsically related in ways that correspond with these qualitative relations. If this constraint were to be satisfied, physical color categories would be physical categories.

However, there's no reason to accept the metaphysical constraint. Furthermore, the perceiver-relativity of physical color categories provides no reason to reject that physical colors are monadic physical properties of objects. Even if color categories are perceiver relative, physical objects have physical colors independently of perceivers. We must distinguish between mental colors, which importantly determine our color categories, and physical colors, which are physical properties of objects.

In this case, the perceiver-relativity of physical color categories is consistent with the proposal that the nature of the colors we attribute to physical objects is physical.

Since we must relativize attribution of physical colors to some perceiver in some viewing conditions and to some mediating process, how do we determine which perceivers and viewing conditions? Ordinarily, we relativize attribution of colors to standard perceivers in standard viewing conditions and to standard mediating processes. In this case, the color attributed is vague--a region in the color space, not a point. But it's not clear that there's a problem having to do with vagueness that would suggest that colors aren't properties of physical objects.

According to Hilbert's version of physicalism, physical colors are reflectance properties, and a difference in reflectance property is sufficient for a difference in physical color. Thus, he claims that physical color categories are physical categories, namely, the categories of reflectance properties. Arguing for this version of physicalism, Hilbert also rejects the dispositionalist's proposal to specify physical colors relative to standard viewing conditions.

He points out that although surfaces that are metameric in standard viewing conditions are indistinguishable in these conditions, they are distinguishable in some nonstandard illumination. Dispositionalism is committed to holding that surfaces that are metameric in standard viewing conditions are the same color. When these surfaces are distinguishable by color in nonstandard illumination, the

visible difference in color is an illusion of color difference.

Since there are real physical differences among metamers, the difference in color visible in nonstandard illumination is due to a real physical difference among surfaces. Thus, dispositionalism, owing to its characterization of physical colors in terms of standard viewing conditions, requires that a real difference in color is an illusion (1987, p. 90). (See Edward Wilson Averill, 1985, pp. 286-288, who offers the same argument, but against Smart's physicalist proposal about the nature of color. Also see Smart's response to Averill, 1987, pp 175-176.)

However, Hilbert's assertion that dispositionalism must account for real differences in color as illusions of differences relies on a notion of what a real difference in color is. Thus, according to Hilbert, if two surfaces look different colors in some viewing conditions and this visible difference correlates with a difference in reflectance properties of surfaces, then the surfaces have different colors.

But this claim seems plausible only because most visible differences in color are real differences in color. Since most visible differences in color are seen in standard viewing conditions, this presents no problem for dispositionalism. But when surfaces that look the same color in standard illumination don't look the same color in

nonstandard illumination, I think we would continue to say that the surfaces as having the same color--unless the nonstandard illumination becomes standard.

Doesn't the nonstandard illumination just show that metameric surfaces aren't really the same color? No. As it turns out, they have different reflectances, and this accounts for the visible difference in nonstandard illumination. But this doesn't show that the surfaces aren't really the same color unless we've already assumed that the real physical color categories are physical categories, namely, categories of reflectance properties.

The dispositionalist simply offers a different proposal about the nature of physical color according to which physical color categories are the familiar categories of reds, greens, and so on. As a result, the dispositionalist draws a different distinction between real and illusory colors. According to this distinction, metamers are the same color. Although red, or even vivid red, in standard viewing conditions is indeterminate with respect to physically different properties, it's not clear that this is a problem at all.

Hilbert offers another argument for the claim that physical color categories are physical categories. This argument is founded on considerations about a visual effect called color constancy along with a characterization of the

biological function of color vision. I'll take up this argument in chapter 5.

#### 3.2.2.4. The Causal Bases of Dispositions

Johnston describes cases where physical objects that aren't red nevertheless would look red to standard perceivers in standard viewing conditions and by standard mediating processes.

For example, a physical object isn't red even though it would look red to standard perceivers in standard viewing conditions and by standard mediating processes, if it would look red due to the magical spell of an angel. Rather, even if a physical object would look red, it isn't red unless it has a physical property that is what Johnston calls a constituting basis of physical red.

Thus, a physical object isn't red even though it would look red, if would look red due to some property independent of the object itself. The physical object isn't red because it doesn't have a constituting basis of physical red (pp. 231-234).

The same considerations can be applied to physicalist proposal about the nature of physical color. For reflectance properties are dispositions to reflect light. Thus according to physicalism, a surface isn't physical red unless it has a constituting basis of physical red.

### 3.2.2.5. Physical Colors as Mind Independent

Johnston proposes that physical colors are standardly mediated dispositions of objects to produce visual experiences of color in specified perceivers in specified viewing conditions. His description of physical colors holds that the perceivers, viewing conditions, and mediating processes can be described with more or less precision. Furthermore, physical colors can be rigidified by describing them in terms of actual specified perceivers, viewing conditions, and mediating processes.

According to Johnston's dispositionalism, physical colors are mind dependent in the sense that they are in part constituted by visual experiences of color.

Considering mind dependence from this standpoint, the mind dependence of physical color is a separate issue from the issue of the precision of descriptions and that of rigidity. Physical colors as dispositions are mind dependent no matter how the dispositionalist further describes them with respect to perceivers, viewing conditions, and mediating processes.

The issues of precision and rigidity have to do with characterizing the context in which physical colors produce visual experiences of color, not with characterizing the nature of physical colors. Physicalists also address the issues of precision and rigidity. Since physicalists hold that physical colors are merely identified by way of our

visual experiences of color, and are not in part constituted by them, these theorists hold that physical colors are mind independent.

However, Johnston shows that even according to dispositionalism physical colors can be mind independent in the sense that they can be rigidified. If physical red is rigidified relative to actual standard perceivers, namely, nonanomalous trichromats, then even if human perceivers' visual systems change so that there are no longer any nonanomalous trichromats, or even any perceivers at all, physical objects would still be physical red. Thus, physical red can be a relation between a physical property of physical objects and merely counterfactual visual experiences of red (p. 230; 1987, pp. 140-141; 1993, p. 106).

Next, I'll examine Johnston's claim that his dispositionalism best agrees with his list of core beliefs about color (Paradigms, Explanation, Unity, Perceptual Availability, and modified Revelation).

### 3.3. Johnston's Argument for Dispositionalism

Johnston's argument for dispositionalism holds that given his list of core beliefs about color, dispositionalism best agrees with these core beliefs. Having rejected the view that the colors we attribute to physical objects are mental properties, the only proposals he considers are

physicalism and dispositionalism.

Johnston primarily argues for dispositionalism on the basis of the epistemological constraint that he calls Perceptual Availability. Thus, I'll first provide a fuller description of Perceptual Availability, and present Johnston's argument that physicalism can't meet this epistemological constraint. I'll then show that this argument depends upon modified Revelation, and evaluate Johnston's argument for modified Revelation.

### 3.3.1. Perceptual Availability

Johnston presents Perceptual Availability in the following terms. Perceivers who have no reason to believe that they are inadequate color perceivers or are in poor viewing conditions are typically justified in holding, simply on the basis of an object's looking vivid red and background beliefs, that it is vivid red (pp. 222-223, p. 241).

A notion of the justification of beliefs about the colors of objects must assume some way of drawing the distinction between real and illusory colors. Johnston draws this distinction such that the real colors of objects are the colors that objects look to standard perceivers in standard viewing conditions (pp. 247-248).

Understanding perceivers and viewing conditions to be standard perceivers and viewing conditions, Perceptual

Availability amounts to the following claim. Perceivers who take themselves to be standard perceivers and to be in standard viewing conditions are typically justified in holding that an object is vivid red, simply on the basis of its looking vivid red and background beliefs (p. 242).

According to Perceptual Availability, beliefs about the color of objects are merely typically justified. There are unusual cases. An object that isn't vivid red nevertheless can look red to standard perceivers in standard viewing conditions due to, for example, nonstandard mediation, or to a causal relation that doesn't involve a constituting base of vivid red (pp. 243-247, pp. 232-234). But in the usual case, perceivers who take themselves to be standard perceivers and to be in standard viewing conditions are justified in believing that an object is vivid red, simply on the basis of its looking vivid red and background beliefs.

The relevant background beliefs are beliefs about ". . . the external causes of visual experience which inform ordinary perception" (p. 223). These beliefs include ". . . beliefs about our perceptual experience being by and large the effects of our perceptual capacities, the circumstances of perception and the intrinsic properties of the things perceived" (p. 242).

I believe that Perceptual Availability is correct. If it weren't typically the case that perceivers who take

themselves to be standard perceivers and to be in standard viewing conditions are justified in believing that an object is vivid red simply on the basis of its looking vivid red and background beliefs, then additional evidence would typically be necessary. Johnston argues convincingly that physical evidence isn't necessary to justify beliefs about the colors of objects (pp. 237-241, p. 253).

Johnston argues against physicalism by claiming that the this view is committed to holding that physical evidence is typically necessary to justify beliefs about the colors of objects, and thus that physicalism is at odds with Perceptual Availability.

### 3.3.2. Johnston's Argument against Physicalism

Johnston claims that competing proposals about the nature of color can be evaluated with respect to how well they agree with his list of core beliefs. He argues that the physicalism meets Unity only if its proponent holds that physical evidence is typically necessary to justify beliefs about the colors of objects. Thus, physicalism's agreement with Unity precludes this view from meeting Perceptual Availability.

Unity is the claim that each shade occupies a place in the color space, a representation of the qualitative similarity relations among colors. Johnston claims that, just as with our beliefs about the colors of objects, our

beliefs about these qualitative similarity relations are justified simply on the basis of our visual experiences and background beliefs. He states,

. . . is it really a matter of scientific discovery that canary yellow is not a shade of blue? No: such similarity and difference principles surely have a different status. We take ourselves to know these principles just on the basis of visual experience and ordinary grasp of color language (p. 237).

Just as with or beliefs about the colors of objects, physical evidence isn't necessary to justify our beliefs about the qualitative similarity relations among colors. Thus, Johnston holds that for a proposal about the nature of color to meet Unity, it must allow that our beliefs about the qualitative similarity relations among colors are justified simply on the basis of visual experiences and background beliefs (pp. 236-237).

Johnston claims that the physicalism could conform to Unity by identifying physical colors as follows. Vivid red is identified as some physical property or other that is related to other physical properties, also identified as colors, in ways that correspond to the qualitative similarity relations described in Unity (p. 237).

In this case, there's no problem with Unity. But only through scientific investigation can we identify the range of physical properties which conform to Unity. Thus, whether a physical object is vivid red depends on whether it has a physical property that is related to other physical

properties in ways that explain the place of vivid red in the color space.

In this case, the physicalist is required to hold that physical evidence is necessary for knowing whether an object is vivid red. For in this case,

. . . what gives one the right to say that there are [vivid red] things is not simply visual perception and the very general background beliefs which inform visual perception, but also and crucially, recherche facts from color science. That is, on this version of the Primary Quality account one is not justified in believing that some things are [vivid red] unless one knows that color science finds that among the causes of our experiences of color are physical properties which stand in certain complex similarity and difference relations (pp. 237-238).

Thus, whether an object has such a physical property is not perceptually available (pp. 236-238).

Johnston anticipates the following objection to his epistemological constraint on meeting Unity. The Unity relations are relations among physical colors as perceived. However, once we know the physical natures of the physical colors, we may find that the relations among these physical natures doesn't correspond with the qualitative similarity relations among physical colors as perceived.

Despite this lack of correspondence between the relations among the physical natures of physical colors and qualitative similarity relations, we have knowledge of the Unity relations, as well as the colors of physical objects, simply on the basis of visual experience (p. 253).

Johnston's response to the physicalist's objection is that in this case, ". . . what we know on the basis of vision leaves it open that canary yellow may nonetheless be as similar to the blues as they are among themselves" (p. 253). If canary yellow is in fact physically as similar to shades of blue as shades of blue are among themselves, then the nature of the colors of physical objects is not at all revealed in visual experience (p. 253).

And, Johnston claims, there is reason to believe that the nature of the colors of objects is revealed in visual experience (pp. 254-259). Thus, at bottom, Johnston's argument against physicalism relies upon modified Revelation.

But clearly physicalism isn't consistent with even a modified version of Revelation. If the colors of objects are monadic physical properties of objects, their physical natures are not revealed at all in visual experience of color. The physicalist must reject Revelation altogether.

Thus, contrary to Johnston's argument, we cannot evaluate whether physicalism or dispositionalism provides the best proposal about the nature of color by finding how well each agrees with his list of core beliefs. The determination to include modified Revelation in the list of core beliefs is alone sufficient to reject physicalism. Therefore, the physicalist must examine Johnston's argument for accepting modified Revelation.

### 3.3.3. Modified Revelation

Johnston claims that the reason to believe that the natures of the colors of physical objects are revealed at all to visual experience is a practical reason. He claims,

. . . our implicit cognitive values favor acquaintance with objects, people, places, and hence with their properties. If that is so then we have reason to want vision to be a mode of access to the natures of visible properties (p. 255).

Johnston's argument for modified Revelation rests on the claim that we are acquainted with physical objects, and that to be acquainted with objects, we must be acquainted with the properties of objects including their colors and shapes (p. 254). Thus, a proposal about the nature of color which is consistent with the colors of physical objects being revealed in visual experience is better than one that isn't because the former concept provides us with something that we value (pp. 254-259).

According to modified Revelation, acquaintance with the colors of objects involves access in visual experience to the qualitative similarity relations referred to in Unity. Johnston isn't explicit about what acquaintance with the shapes of objects involves. Presumably, it involves access to categories by which we classify physical shapes as similar or dissimilar. (Johnston also doesn't indicate whether acquaintance with shapes of objects indicates that shapes are response dispositions. Since it seems

implausible that shapes are response dispositions, it seems that Johnston holds that acquaintance is a necessary but not sufficient condition for being a response disposition.)

But do we have any access at all to the nature of color? Johnston argues that we unless we are acquainted with physical objects, we'll have skeptical worries. Unless visual experience acquaints us with the natures of properties of physical objects, including their colors, then it's possible that our beliefs about objects are systematically false. Johnston contends, if we are not acquainted with the natures of the properties of objects, then visual experience "leaves completely open" what the nature of the causes of our visual experience is (p. 257).

In particular, Johnston claims that if we are not acquainted with the natures of the properties of objects, including their colors, then in experiencing the external world, for example, in seeing a landscape, we can't distinguish between the following two possibilities. One possibility is that objects experienced as making up the landscape cause the experience.

Another possibility is that through carefully contrived neural stimulation, a neuroscientist causes the experience. Unless the latter possibility can be ruled out, we might worry that our beliefs about the external world are systematically false. But we can only rule out such a possibility by accepting that we are acquainted with

properties of the objects we experience.

If the physicalist allows that the relations among the physical natures of colors don't correspond with the qualitative similarity relations among physical colors as perceived, Johnston claims, the result is "that we are not at all acquainted with the colors but only with their visual effects" (p. 255).

But the physicalist must resist being committed to the claim that we are acquainted with visual effects, namely, properties of visual experiences. Even though the physicalist can admit that we know, simply on the basis of visual experience, relations of qualitative similarity among perceived colors, this admission does not commit the physicalist to any form of acquaintance.

Acquaintance involves knowledge of natures. The physicalist contends that knowledge of Unity relations is not knowledge of natures. So, for example, the physicalist admits that it's possible that the properties orange and brown that we attribute to physical objects are the same physical color. We can explain the difference between experiences of orange and of brown on the basis of a psychological theory of perception.

Furthermore, the qualitative similarity relations among visual experiences of color are explained in terms of neurophysiology. Our knowledge, simply on the basis of visual experience of color, of the qualitative similarity

relations among visual experiences provides no access to their neurophysiological nature. Thus, the physicalist rejects knowledge, simply on the basis of experience, of the neurophysiological natures of our visual experiences just as this theorist rejects knowledge, simply on the basis of experience, of the physical natures of the colors of objects. (See Lewis, 1995; Lewis, forthcoming, pp. 2-3, pp. 16-17, who holds this view.)

Johnston's notion of acquaintance is tailor-made to solve the skeptical worries that he points to. Moreover, Johnston seeks to make the skeptical worries gripping by his assertion that the physicalist holds that we are not at all acquainted with the colors of objects but only with their visual effects. For then the physicalist seems to hold that while we have a high status of knowledge of visual experience, we have a relatively low status of knowledge of the colors of objects.

Johnston states, "[t]his deeper problem of the external world is the problem of acquaintance, the problem of how we could be acquainted with anything given the nature of information transmission" (p. 256). The physicalist holds that our experience of objects "leaves completely open what their natures might be like" (p. 257).

But without the contrast in status of knowledge where some knowledge is of a high status because it is of natures, and some knowledge is of a lower status because it isn't,

the skeptical worries, while about logical possibilities, have less force. In this case, although the physicalist holds that our experience leaves completely open what the natures of objects might be like, this theorist doesn't thereby hold that it leaves completely open what external objects and their properties might be like. Even if visual experience of color doesn't provide access to natures--neither of the physical colors nor of the visual experiences--it still provides access to colors and visual experiences.

As I'll conclude in chapter 5, the best proposal about the nature of physical colors takes Johnston's description of physical colors to be in many respects correct. Physical colors are correctly described as physical properties of objects that, by virtue of standard mediating processes, produce visual experiences in actual specified perceivers in actual specified viewing conditions. Furthermore, the considerations about how to determine the specification of perceivers and viewing conditions are as Johnston presents. Perceivers and viewing conditions are usually specified as standard.

However, rather than hold that physical colors are dispositions, and thus relations to visual experiences, I hold that physical colors are monadic physical properties of objects. The description of physical colors--as physical properties of objects that, by virtue of standard mediating

processes, produce visual experience in actual specified (usually standard) perceivers in actual specified (usually standard) viewing conditions--serves as a reference-fixing description of these monadic properties. Physical colors are not in part constituted by visual experiences; they are only identified by way of visual experiences. (See Kripke, 1972, p. 140, fn. 71, for a similar proposal.)

In this case, far from leaving completely open what the colors of objects might be like, the physicalist provides a subtle description. With respect to natures, the physical natures of the colors of objects are whatever physical properties are identified by the description. Thus, while the description may be highly specific about the colors of objects, by specifying perceivers, viewing conditions, and mediating processes very precisely, it leaves open what particular physical properties fit the description.

According to Johnston, acquaintance adds force to skeptical worries and also puts these worries to rest. But acquaintance plays these roles only if we assume that knowledge of objects and their properties requires knowledge of natures.

(Johnston has, since "How to Speak of the Colors," rejected dispositionalism. He now holds, "[t]he colors are relational qualities of external objects whose qualitative nature is revealed by experience" [unpublished manuscript b, p. 16]. He points to the shifting colors of the backs of

compact discs as instances of colors that "wear their light- and observer-dependent natures on their face" [unpublished manuscript b, p. 15].

According to Johnston, all colors are relational in the way that the shifting colors of compact discs are, even if they don't appear to be in ordinary experience. Thus, although Johnston has rejected dispositionalism, he hasn't rejected the claim that color perception provides partial access to the nature of colors.

With respect to dispositionalism, he claims

[t]he real mistake in Dispositionalism was the attempt to identify such relational qualities with relations to qualia-instantiating experiences of subjects. The colors are relative to subjects (as well as to viewing conditions.) But they are not in any deeper way subjective [unpublished manuscript b, p. 16].

[See also Johnston, 1996a, pp. 197-198 in which he presents doubts about dispositionalism.]

#### 4. Peacocke's Dispositionalism

In "Colour Concepts and Colour Experiences" (1984a), Peacocke proposes that the colors we attribute to physical objects in visual experience are dispositions to produce visual experiences of color. He, like Johnston, argues for dispositionalism on the basis of epistemological considerations. But for Peacocke the motivating epistemological considerations aren't skeptical worries.

Rather, Peacocke examines the role qualia play in conditions required for possession of concepts of physical colors. Peacocke takes qualia to be sensory qualities that determine what it's like to experience physical objects as colored (1983, p. 5).

As with Johnston's argument for dispositionalism, Peacocke uses considerations about our concept of physical color to provide the basis for a proposal about the nature of physical color. But rather than constrain a proposal about the nature of physical color by a list of core beliefs, Peacocke's ingenious strategy is to claim that color qualia are required for possession of physical color concepts. He then argues that only dispositionalism can explain why qualia are required for possession of physical color concepts.

Peacocke claims that possession of the concept of

physical red requires "knowing what it is like to have a visual experience as of a red object" (p. 408).<sup>1</sup> He offers epistemological arguments that hold that color qualia are necessary for possessing physical color concepts.

If Peacocke can establish this claim, then his dispositionalist proposal is strongly supported. For Peacocke tailors his dispositionalism to explain why color qualia are necessary for possessing physical color concepts.

How do considerations about the necessary conditions for possessing physical color concepts, or, as Peacocke calls them, possession conditions for physical color concepts, determine the issue of the nature of physical colors? After all, these conditions, being requirements for our having the physical color concepts, are epistemological requirements.

However, if possession conditions for a concept require access to the property by way of a specific sensory modality, then perhaps this is best explained by the claim that qualia are part of the nature of the property. Peacocke provides such an epistemological requirement for possessing the concept of physical color. He claims that the concept of a physical property that isn't visually experienced couldn't be the concept of a physical color.

If this claim is true, perhaps it is best explained by

---

<sup>1</sup> All reference in this chapter are to Peacocke, 1984a, unless otherwise noted.

the claim that qualia, which determine what it's like to experience physical objects as colored, are part of the nature of physical color.

I shall first describe Peacocke's dispositionalism. The primary characteristic of this proposal about the nature of physical color is that it draws a distinction between physical color and mental color, the latter range of properties described as color qualia. With this distinction, Peacocke provides explanations of the phenomenology of color, as well as of possession of physical color concepts.

I shall briefly describe Peacocke's general account of possession conditions for concepts before addressing arguments for the claim that qualia are necessary for possession of physical color concepts. I'll show that this general account doesn't itself determine the specific issue of whether qualia are necessary for possession of physical color concepts. Rather, epistemological arguments, which are independent of the general account of possession conditions for concepts, are required.

I shall then consider support for Peacocke's claim that qualia are necessary for possession of physical color concepts. I'll attempt to undercut Peacocke's arguments for dispositionalism by showing that these arguments fail.

#### 4.1. The Relation between Color Concepts and Color Experiences

Peacocke uses the word "concept" interchangeably with the expression "mode of presentation." He applies the same concept of concept to properties and objects (1984, p. 408; 1992b, p. 2). Following Frege, Peacocke holds that modes of presentation are distinct if and only if identity statements that relate modes of presentation of the same object or property can be informative (1983, pp. 89-90; 1992b, p. 2).

Peacocke also claims that a concept is individuated by its possession conditions, that is, the conditions that must be met for the possession of the concept. Thus, an account of modes of presentation is given by an account of possession conditions. Possession conditions for a concept specify the abilities that one must have, for example, the inferences that one must be able to make, to possess the concept and thus to be related to intentional contents that contain that concept (1992b, pp. 5-8). I shall discuss Peacocke's account of possession conditions further in section 4.1.2.

According to Peacocke, concepts, or modes of presentation, of properties can be perceptual rather than descriptive modes of presentation (1983, p. 89). Perceptual modes of presentation are characterized by a sensory modality. Thus, they capture what it's like to experience a

property by way of a particular sensory modality (p. 408; 1983, p. 191).

Since, it can be informative that a physical shape experienced tactually is the same as a shape experienced visually, what it's like to experience a property by way of a particular modality is sufficient for distinguishing modes of presentation, and so concepts, of that physical shape (1983, p. 191).

Peacocke distinguishes between physical colors and mental colors, which he claims are color qualia. To make the distinction between these two ranges of properties explicit, Peacocke refers to color qualia by primed predicates, such as "red'."

The property red' is the property included in the perceptual mode of presentation of the property red which determines what it's like to experience physical objects as red. Peacocke holds that qualia such as red' are ". . . properties an experience has in virtue of some aspect--other than its representational content--of what it is like to have that experience" (1983, p. 5). The property red is a physical property of physical objects.

Peacocke defines physical color concepts in terms of primed colors. He defines the concept of a physical object's being red as the concept of a physical object being disposed in normal circumstances to cause the region of the visual field in which it is presented to be red' in normal

humans. The concept of red, which is defined in terms of red', is included in the content of visual experiences of red objects (p. 413).

Because the concept of red is defined as the concept of a disposition to produce red' visual experiences, the physical property this concept refers to is a relation between a physical property of objects and red'. Thus, a physical property can't be red unless instances of the property are disposed to cause instances of red'.

However, Peacocke does not define the concept of a visual experience being red' in terms of the property red. Rather, the concept of a visual experience being red' has its reference fixed by red physical objects (1983, p. 21; p. 413).

Although primed colors are properties in virtue of which there's something it's like to experience physical objects as colored, it's not qualia that we're aware of in visual experience and attribute to physical objects. The colors we are aware of and attribute to objects are physical colors.

Thus, the claim that the property red' determines what it's like to experience physical objects as red is not to be construed as follows: the property red' causes us to experience physical objects as being red'. In this case, the only color we are aware of is the property red', and we attribute this property to physical objects.

Rather, the claim is that the property red' determines what it's like to experience a physical property of objects. When we experience a physical property of objects as determined by the property red', we are aware of the physical object as red. This point plays a crucial role in Peacocke's explanation of the phenomenology of color in terms of primed colors.

With this general discussion of Peacocke's dispositionalism, I will describe how the inclusion of primed colors in the contents of visual experiences explains the phenomenology of physical colors.

#### 4.1.1. The Phenomenology of Color

Peacocke explains the phenomenology of the colors of objects in a straightforward way. He proposes that the property red that we are aware of in visual experience is a physical property, and what it's like to experience physical objects with this physical property is determined by red'. This description allows both that we experience physical colors as properties of objects, and also that we don't experience physical colors as physical properties.

Two kinds of objections are made against this explanation. One objection, as put forward by Boghossian and Velleman (1989, pp. 94-96), is that Peacocke is committed to holding that in experience of the property red, we are aware of red' as distinct from red. According to the

other objection, as made by Armstrong (in Armstrong and Malcolm, 1984, pp. 169-174) and Harman (1990, pp. 34-40), the phenomenology of color need not appeal to qualia such as red'.

As I discussed in section 2.1.2.1., Boghossian and Velleman (1989, pp. 94-96) claim that Peacocke is committed to holding that in visual experience of red, we're aware of red' as distinct from red. This clearly presents a false phenomenology.

Boghossian and Velleman also assert that any form of dispositionalism is committed to the claim that we experience the colors of objects as dispositions. Since, in any case, we don't experience properties that are dispositions as dispositions, this also conflicts with the phenomenology of color.

Boghossian and Velleman's phenomenological objections rely on the assumption that awareness of color in visual experience provides us with access to the nature of color (1991, pp. 85-86). It is only on the basis of this assumption that they conclude that Peacocke is committed to holding that red' is attributed to physical objects in visual experience. They assume that if red' is part of the nature of the property red we attribute to objects, then we must attribute red' to physical objects.

Also, assuming that visual experience provides access to the nature of colors, if the colors we attribute to

objects were dispositions, then we would experience colors as dispositions. But we don't. So, on this assumption, the colors we attribute to objects aren't dispositions.

Boghossian and Velleman do not defend their assumption. Furthermore, their assumption amounts to a denial of physical colors. But, as I argue in chapter 2, there are compelling reasons to accept physical colors and so deny Boghossian and Velleman's assumption.

Thus, the phenomenological objection against Peacocke, which relies upon this assumption, is unfounded. (See also McGinn, 1996, pp. 540-542, who argues against dispositionalism on the basis of phenomenological considerations similar to those of Boghossian and Velleman. He also claims without argument that we have access to the nature of color simply through visual experience.)

But must an explanation of the phenomenology of color appeal to primed colors at all? According to the other type of objection to Peacocke's explanation of the phenomenology of color, visual experiences don't have qualia. Armstrong (Armstrong and Malcolm, 1984, pp. 169-174) and Harman (1990, pp. 34-40) would object to Peacocke's explanation of the phenomenology of color on these grounds.

I argue in chapter 1 that there are good reasons to hold that there mental colors. But I deny that mental colors are color qualia, qualitative mental properties that are necessarily conscious.

In chapter 1, I give a general reason to deny that mental colors are color qualia. This general reason takes the following form. If we hold that mental colors are color qualia, and thus are necessarily conscious, then we cannot explain mental colors in nonmental terms. But, as Clark argues, it seems that we are already well advanced in having such an explanation of mental colors in terms of neural properties of the visual system. Thus, these explanations give us a general motivation for denying that mental colors are qualia.

Peacocke offers specific arguments for the conclusion that color qualia are included in the contents of visual experiences of physical colors. Thus, to defend my rejection of qualia, I must respond to these specific arguments.

Peacocke offers arguments for accepting color qualia in the context of considerations about possession conditions for physical color concepts. Thus, I'll first give a description of Peacocke's account of possession conditions for color concepts. Then I'll consider his arguments for the claim that qualia are necessary for possession of physical color concepts.

#### 4.1.2. Possession Conditions for Color Concepts

I shall briefly discuss some general aspects of Peacocke's account of possession conditions for concepts

before addressing arguments for the claim that qualia are necessary for possession of physical color concepts. In particular, I shall describe what possession conditions are, how they differ from Fregean definitions, and consider Peacocke's strategy for providing a noncircular account of possession conditions for concepts. In discussing these general aspects, I'll use illustrations involving the concept of red.

One might assume that if, as Peacocke holds, the concept of red is defined in terms of red', then one must have knowledge of which visual experiences are red'--and thus have the concept of red'--before one can have the concept of red. Furthermore, the Fregean notion of definition, which Peacocke endorses (1983, p. 109), seems to support this assumption.

A Fregean definition relates terms that express the same concept. On this notion of definition, if the concept of red is defined as a disposition to produce red' visual experiences in standard perceivers in standard circumstances, it should be uninformative that something that is red also is disposed to produce red' visual experiences in standard perceivers in standard circumstances. Peacocke's definition seems to require that we understand which visual experiences are red'--and thus to have the concept of red'--before we can acquire the concept of red.

But Peacocke denies that he is "committed to the consequence that anyone who can exercise the concept of redness also has to have the sophisticated concept of experience [as characterized by red']" (p. 412). His definition of the concept of red as a disposition to produce red' visual experiences doesn't relate terms that express the same concept. Thus, it seems, his proposed definition of red doesn't meet a fundamental constraint of Fregean definition. (See Michael Smith, [1986], pp. 561-562, who makes this objection.)

Peacocke responds to this objection by distinguishing his definition of the concept of red in terms of red' from Fregean definition.

The definition of the concept of red in terms of the property red' does relate different concepts (although these concepts have the same reference, namely, the property red) (1992b, pp. 9-10). However, Peacocke claims that the definition of the concept of red in terms of red' explains what it is to have the concept of red (p. 409). The definentia of such definitions specify necessary conditions for the possession of concepts, or, in other words, possession conditions for concepts (1992b, p. 6).

Since both sides of Peacocke's definition of the concept of red refer to the same property, those who do know the possession condition for the concept of red apply the word "red" in the same way as those who don't know, but

merely satisfy, the possession condition. Peacocke holds, ". . . the judgements of one who has the concept of being red are responsive to experience and evidence in exactly the same ways as would be the judgements of one who explicitly used the definition" (p. 414). Possessing the concept of red merely requires using this concept in the correct way and thus satisfying its possession condition.

However, the distinction between Fregean definition and the definitions that specify possession conditions for concepts opens up what Peacocke calls the nonpossession possibility (1986, p. 579). The nonpossession possibility is the possibility that one satisfies the possession condition for the concept of red but, nevertheless, cannot specify the possession condition for this concept (1986, p. 579).

Possession conditions for the concept of red specify the abilities that one must have to possess the concept of red and thus to be related to intentional contents that contain that concept (1992b, pp. 5-8).

In "Colour Concepts and Colour Experiences," Peacocke holds:

. . . in mastering the predicate 'red' of objects, one comes to be disposed to apply it to an object when the region of one's visual field in which it is presented is red' and circumstances are apparently normal (and when one has indirect evidence that it would meet this condition were it so presented) (p. 412).

In A Study of Concepts, this statement is elaborated as

follows:

The concept red is that concept C to possess which a thinker must meet the these conditions:

(1) He must be disposed to believe a content that consists of a singular perceptual-demonstrative mode of presentation m in predicational combination with C when the perceptual experience that makes m available presents its object in a red' region of the subject's visual field and does so in conditions he takes to be normal, and when in addition he takes his perceptual mechanisms to be working properly. The thinker must also be disposed to form the belief for the reason that the object is so presented.

(2) The thinker must be disposed to believe a content consisting of any singular mode of presentation k not meeting all the conditions on m in (1) when he takes its object to have the primary quality ground (if any) of the disposition of objects to cause experiences of the sort mentioned in (1) (1992b, pp. 7-8).

I shall focus on a feature that these descriptions share. Each description includes the property red' in an attempt to avoid circularity in the specification of possession conditions for the concept of red. The avoidance of circularity is a constraint on any account of the possession of any concept.

If the possession condition for a concept were to include that very concept within an intentional context, then the possession condition would be circular. Since intentional contents are constituted by concepts, such an account would presuppose an account of possession of the concept.

Thus, in the case of the concept of red, we can't appeal to the intentional contents of visual experiences of

red to explain possession of the concept of red.

Fundamental to avoiding circularity in the account of possession of the concept of red is the distinction between the intentional and nonintentional properties of visual experiences. Peacocke's proposed possession conditions for the concept of red appeals to red', which is a nonintentional property of visual experiences of red.

Peacocke states that possession conditions for the concept of red that include red' do "tacitly" appeal to the concept of red (1992b, p. 8). For the reference of the concept of red' is fixed by red physical objects (1983, pp. 19-21; 1992b, p. 8). But because the concept of red' isn't defined in terms of red, the possession condition isn't circular.

Furthermore, if the nonpossession possibility holds, one can both have red' experiences and learn the correct application of the word "red" without possessing the concept of red'. Peacocke holds, "[a]ll [that's] require[d] for the possession of the concept of redness is a certain pattern of sensitivity in the subject's judgments to the occurrence of red' experiences . . . ." (p. 412). This sensitivity of judgments to red', on pain of circularity, can't presuppose having the concept of red.

Thus, sensitivity of judgments to the property red' purports to explain how we can have the concept of red without having the concepts of red' or of visual experience.

Smith (1986) raises the following objection to this explanation. How can red physical objects be judged as red in cases where they aren't seen? Perhaps in the cases where red physical objects are seen, judgments are sensitive to actual occurrences of the property red' produced by red objects. But in cases where objects aren't seen, there is no actual occurrence of the property red' for judgments to be sensitive to.

Furthermore, if Peacocke holds that judgments are sensitive to evidence that objects would produce red' if they were seen in normal circumstances, then it seems that one must have the concept of red' to judge that objects that aren't seen are red.

Referring back to Peacocke's two statements of the conditions for possession of the concept of red, the parenthetical clause in the first statement and condition (2) in the second description have to do with application of the concept of red to unperceived objects. I shall consider condition (2), which refines and elaborates the parenthetical clause in the first statement. (See Peacocke, 1986, which indicates that the refinement and elaboration of this clause was in part driven by Smith's criticisms.)

In condition (2), Peacocke holds that in the case of an unseen object, and thus in a case where (1) isn't met, one judges that the unseen physical object has the physical ground to produce visual experiences with the property red'.

If the nonpossession possibility holds, satisfying condition (2) of the possession condition doesn't require being able to specify this condition, and, in particular, it doesn't require having the concept of red'.

All that's required to satisfy condition (2) is sensitivity of judgments to certain evidence. This evidence is specified as evidence that a physical object has the physical ground to produce visual experiences with the property red'. Peacocke holds that one's judgments can be sensitive to such evidence, whether or not one can specify the evidence as such.

Without the concepts of red' or of visual experience how are we to explain sensitivity of judgments to evidence that a physical object produces visual experiences with red'? Peacocke holds that this sensitivity simply consists in a pattern of causal relations among visual experiences and propositional attitudes described by the possession condition for the concept of red. These causal relations are thus relations in which mental states are disposed to cause other mental states.

Peacocke calls such causal relations transitions among mental states. He asserts that the transitions among mental states described in the possession condition for the concept of red are primitively compelling (1992b, pp. 6-8). A transition among mental states is primitively compelling if it can be described as compelling, but not due to any

inference involving other mental states. Thus, such transitions aren't justified by other mental states (1992b, p. 6).

In sum, Peacocke's account of the possession condition for the concept of red relies on two claims. The first is the claim that it's possible that one can satisfy the possession conditions for a concept even though one isn't able to specify these possession conditions. The second claim is that the transitions among mental states that constitute sensitivity of one's judgments to visual experiences with the property red' are primitively compelling.

Smith's objections to Peacocke's account are inconclusive because they don't give us any reasons to reject either of these claims.

Peacocke's account of possession conditions for concepts provides the context in which he asserts that red' is required for possession of physical color concepts. Having described general features of Peacocke's account of concepts, I shall now consider his arguments for the claim that having visual experiences with red' is required for possessing the concept of red.

Peacocke doesn't claim that the general features of his account of concepts support the claim that the property red' is necessary for having the concept of red. As I'll discuss below, Peacocke admits the challenge of providing a

noncircular account of possession conditions for the concept of red needn't be met by an appeal to the property red' (1992b, p. 8).

Rather, he provides epistemological arguments, which are independent of his general account of concepts, for the claim that the property red' is required for possession of the concept of red.

#### 4.2. Physical Red and Red'

It is the claim that the property red' is necessary for possession of the concept of red that supports Peacocke's conclusion that the property red is a relation between physical properties of objects and the property red'. In the remainder of this chapter, I shall attempt to undercut his argument for dispositionalism.

I'll describe Peacocke's own suggestion of an account of the concept of red which doesn't appeal to the property red'. However, Peacocke rejects such an account on the basis of a number of arguments that purport to show, independently of considerations about circularity, that the property red' must be included in possession conditions for the concept of red. These arguments serve to motivate the claim that possession of the concept of red requires having visual experiences with qualia, a qualitative mental property that determines what it's like to experience physical objects as red.

#### 4.2.1. Red' and Noncircularity

Peacocke holds that an account of possession of a concept can't appeal to the intentional contents which include the concept. It is the relation to just such contents that's to be explained. However, the account can refer to nonintentional properties. So far, I've described Peacocke's account of the concept of red, which appeals the nonintentional property red'. But, as Peacocke himself proposes, such an account needn't appeal to qualia.

Peacocke proposes that there are representational mental states that do not have intentional contents. Intentional contents are constituted by concepts. Thus, representational states that are at the same time nonintentional have contents that are not constituted by concepts. Peacocke calls such nonintentional contents nonconceptual contents.

Another way of distinguishing nonconceptual contents from intentional contents is in terms of possession conditions. If one can have a representational state without satisfying possession conditions for concepts, then the state has a nonconceptual content.

Nonconceptual contents are similar to intentional contents in that they are evaluable as either true or false. Also, mental states can have nonconceptual contents that represent objects and properties that don't exist.

However, according to Peacocke nonintentional contents

are constituted by (actual or nonactual) objects and properties. Thus, they are distinct from intentional contents, which are constituted by concepts of (actual or nonactual) objects and properties.

Peacocke proposes two types of nonconceptual contents: scenario contents and protopositional contents. Scenario contents are contents of perceptual experiences which are constituted by properties occupying some portion of space as experienced by a perceiver. This content can be specified by a detailed description of how the space is occupied:

For each point . . . identified by its distance and direction from the origin, we need to specify whether there is a surface there and, if so, what texture, hue, saturation, and brightness it has at that point, together with its degree of solidity. The orientation of the surface must be included. So must much more in the visual case: the direction, intensity, and character of light sources; the rate of change of perceptible properties, including location; indeed, it should include second differentials with respect to time where these prove to be perceptible (1992b, p. 63).

A scenario content is true if such a description matches the actual surroundings of the perceiver (1992b, pp. 61-64).

Having a representational state with scenario content doesn't require being able to provide any description of the properties that are represented by the content. Having a state with scenario content involves no more than being perceptually conscious of a portion of space from an egocentric point of view (1992b, p. 63, p. 68).

Protopositional content is also a content of

perceptual experience. It is constituted by objects, properties, and relations experienced as located within parts of space represented by scenario content (1992b, p. 77). Protopositional content is distinct from scenario content in that it merely represents salient objects and properties and relations rather than the perceptible properties of each point in a part of space (1992b, p. 78).

Also, protopositions include relatively complex relations among points, lines, and regions. Such properties and relations, including the property square and the relations same shape as, parallel to, and symmetrical about, aren't represented by scenario content (1992b, pp. 74-77).

Protopositional content is distinct from conceptual content in that it is constituted by objects, properties, and relations rather than concepts of objects, properties, and relations (1992b, p. 77).

Peacocke claims that the contents of intentional states can be explained in terms of their relations to perceptual experiences with nonconceptual contents. Such explanation are noncircular, since nonconceptual contents are nonintentional (1992b, pp. 66-67).

An evaluation of Peacocke's proposal of nonconceptual contents is beyond the scope of this work. But according to this proposal, there are nonintentional properties of perceptual experiences other than qualia that can be appealed to in an account of concepts.

For example, the property of square is included in protopositional contents. Sensitivity of judgments to its inclusion in protopositional contents allows a noncircular account of the concept of square. Furthermore, this account of the concept of square doesn't appeal to qualia. Can there be a similar account of the concept of red?

Peacocke claims that there can't because there is a special connection between possession of the concept of red and visual experience. Next, I will examine this special connection and consider Peacocke's claim that it shows the property red' is required for possession of the concept of red.

#### 4.2.2. Physical Red and Knowing What It's Like

Peacocke offers two arguments for the claim that the property red' is necessary for possession of the concept of red. The first concludes that the property red' is necessary due to considerations about the special connection between the concept of red and visual experience.

The second argument holds that the property red' is necessary to explain an aspect of visual experience of physical color which the inverted spectrum thought experiment purports to make salient.

#### 4.2.2.1. Physical Red and Visual Experience

Peacocke holds that a congenitally blind person wouldn't have the concept of red:

if he employed some instrument which is sensitive to the reflectance properties of surfaces, and which gives this information in auditory form through a small loudspeaker. He may come to use this device unreflectively, and have beliefs about the properties of surfaces, beliefs which are caused by the auditory experience produced by the instruments, and which are not based on inference (p. 410).

But according to physicalism, physical colors of surfaces just are reflectance properties. Thus, according to physicalism, the congenitally blind person can have the concept of physical color even though he doesn't have visual experiences at all. Moreover, this person can possess the concept of physical colors by virtue of the auditory experiences produced by the instrument.

Peacocke claims that because physicalism allows the possibility of access to physical colors by modalities other than vision, it "lacks any component which would explain why possession of the concept [of red] and full understanding of the word ["red"] is so closely tied to visual experience" (p. 410).

Furthermore, Peacocke claims that the congenitally blind person can't possess the concept of physical color even though he noninferentially identifies reflectance properties by way of auditory experiences. Thus, possessing the concept of physical color requires not just

noninferential access to properties of physical objects, but also visual access.

The proposal that the property red is a relation between physical properties of objects and the property red', and thus is in part constituted by a property of visual experience, provides a simple and satisfying explanation of why the concept of red is closely tied to visual experience.

The physicalist allows that vision is the only perceptual modality directly sensitive to physical colors. (By direct sensitivity or access to physical color by way of visual experience, I mean experiential sensitivity or access to physical color that isn't mediated by experience of another property which serves as an indicator of physical color. Indirect sensitivity or access to physical color is sensitivity that is mediated in this way.)

However, Peacocke denies that it's contingent that vision is the only perceptual modality directly sensitive to physical colors. He claims that it's a "necessary truth that one cannot experience objects as red in modalities other than the visual" (p. 411).

The claim that it's a necessary truth that vision is the only perceptual modality directly sensitive to physical colors indicates that ordinary visual experience provides access to an aspect of the nature of color. For the only

way to explain this necessary truth is to hold that physical colors are relations between physical properties of objects and properties of visual experiences. In this case, there can be no access at all to physical colors except in visual experience (p. 408).

But then the claim that it's a necessary truth that one cannot experience objects as colored except by visual experience is simply incompatible with physicalism. Moreover, the example of auditory detection of reflectance properties does not demonstrate that the relation between physical colors and visual experience is necessary.

Clearly, the noninferential access to reflectance properties by virtue of an auditory signal doesn't allow the blind person to hear colors. Rather, he hears an auditory signal, which happens to be correlated with reflectance properties. He has noninferential but indirect access to reflectance properties.

But that the auditory signal doesn't allow the blind person to hear colors doesn't show that it's necessary that vision is the only human perceptual modality directly sensitive to physical colors. Indeed, the physicalist holds that it's contingent that vision is the only perceptual modality directly sensitive to physical colors. If physicalism is true, this is all that the claim that we can't hear, feel, taste, or smell colors amounts to.

Furthermore, by accepting that vision is the only

perceptual modality directly sensitive to physical color, the physicalist allows that there is a special relation between physical color and visual experience. This relation, while special, is contingent. Thus, this special relation needn't be explained by the proposal that physical colors are relations between physical properties of objects and properties of visual experience.

To establish his proposal about the nature of color, Peacocke must give us a reason for holding that it's necessary that vision is the only perceptual modality directly sensitive to physical colors. In an argument for the possibility of an inverted spectrum, Peacocke attempts to give us such a reason.

#### 4.2.2.2. The Inverted Spectrum

Peacocke presents the inverted spectrum thought experiment to support the claim that physical colors aren't monadic physical properties of objects. The inverted spectrum thought experiment suggests that physical properties are irrelevant in determining the colors we experience physical objects as having. Rather, this thought experiment suggests that qualitative mental properties of visual experience, namely, color qualia, alone determine this.

Assuming that physical colors are properties of physical objects which we experience as colors, if visual

experiences of color have color qualia, which alone determine the colors we experience physical objects as having, then physical colors cannot be monadic physical properties. Rather, physical colors are relations between physical properties of objects and color qualia.

(Shoemaker claims both that visual experiences have qualia and that physical colors are monadic physical properties of objects. However, Shoemaker holds that the properties of physical objects which we experience as colors aren't physical colors, but rather relations between physical properties of physical objects and visual experiences with color qualia. Physical colors are rather the physical bases of these relations, and these physical properties are represented in the intentional contents of visual experiences of colors [1996, pp. 58-66].)

#### 4.2.2.2.1. Peacocke's Argument

Peacocke describes the thought experiment as follows. At a certain point in time, surface with reflectance property G causes visual experiences of green surfaces in normal human perceivers in normal viewing conditions; surfaces with reflectance property R causes visual experiences of red surfaces. At a later time, due to a switching of neural states in normal human perceivers R causes visual experiences of green surfaces while G causes visual experiences of red surfaces. In this case surfaces

with G at the earlier time looks the same color as surfaces with R at the later time--they both look green.

This case seems possible, but the proposal that physical colors are physical properties such as reflectance properties can't account for its possibility. Physicalism holds that the only qualitative properties that could account for physical objects looking the same or different with respect to color are physical colors, which are physical properties of objects, such as reflectance properties.

To account for the possibility of this case, it seems that we must appeal to qualitative mental properties of visual experience itself, which alone determine what it's like to visually experience reflectance properties of surfaces. For the thought experiment seems to provide a case where physical properties of objects are irrelevant in determining whether a physical object is experienced as red or green.

Thus, it seems plausible to hold that visual experiences have color qualia. Since qualia alone determine whether an object is experienced as red or green, Peacocke concludes that physical objects don't have colors independently of qualia. Rather, physical colors are relations between physical properties of objects and color qualia. In this case, visual experience with color qualia provides access to an aspect of the nature of color.

The inverted spectrum thought experiment is more commonly used to argue for qualia independently of considerations about physicalism about color. However, I'll only consider use of the inverted spectrum thought experiment for the purpose of rejecting physicalism about color.

When the thought experiment is used to reject physicalism, it is assumed that intersubjective or intrasubjective switches in the color experiences produced by physical objects are detectible. Knowledge of switches in color experiences is provided as evidence that physical properties of physical objects aren't relevant in determining our experience of the colors of physical objects.

Descriptions of the inverted spectrum thought experiment commonly ask us to assume that it's possible that a switch in neural states is sufficient to bring about a switch in the color physical objects are experienced as having (or, as I'll say, experienced color). Theorists who claim that perceptual experiences have qualia and also accept mind-body materialism, must characterize the relation between qualia and neural properties in some way. Block, and Shoemaker, for example, hold that qualia supervene on neural properties, where supervenience is a nonexplanatory metaphysical relation (Block, 1990, pp. 65-66; Shoemaker, 1982, pp. 374-375).

Thus, relying on this supervenience claim, if the neural states on which visual experiences of red and green supervene switch, then physical objects that look red before the switch look green after the switch.

Is there reason to believe that identity of neural state is sufficient for identity of experienced color? From the standpoint of this question, the presentation of the inverted spectrum thought experiment is simply question begging with respect to physicalism about color.

By assuming supervenience of experienced color on neural states, one simply assumes that the supervenience base for experienced color doesn't involve causal relations with physical properties of objects. In this case, physical properties of objects play no role in determining the colors we experience physical objects as having.

But the physicalist rejects the assumption that physical properties of objects are irrelevant in determining the colors we experience physical objects as having. For the thought experiment to provide an argument against the physicalist, there needs to be support for the claim that identity of neural state is sufficient for identity of experienced color.

#### 4.2.2.2.2. Pseudonormal Vision

Martine Nida-Rumelin (1996) presents empirical research into color vision disorders to support the claim that

spectrum inversion is possible. She asserts that the possibility of spectrum inversion is indicated by a widely accepted scientific explanation of red-green blindness in human beings.<sup>2</sup>

The explanation of red-green blindness is that in individuals with this disorder, the cones sensitive to the longwave region of the spectrum (the L cones) and those sensitive to the middlewave region (the M cones) contain the same photopigment.

According to the opponent process theory, the visual system encodes physical red and physical green by gauging the difference in the activation of the M cones from that of the L cones. If the M and L cones contain the same photopigment they are activated identically, with the result that physical red and physical green are indiscriminable.

In some red-green blind individuals, the M and L cones contain the same photopigment because L cones contain the photopigment normally contained in M cones. In other red-green blind individuals the opposite is true: M cones contain the photopigment normally contained in L cones. Genetic defects explain how M and L cones can contain the same photopigments. The genetic theory which provides this

---

<sup>2</sup> As Nida-Rumelin points out (1996, p. 155, fn. 2), Boynton, 1979, pp. 356-358, refers to the same scientific explanation and makes the same conclusion with respect to the possibility of inverted perceived colors. Hilbert, 1987, p. 92, fn. 11, makes note of Boynton's discussion, but doesn't comment on it.

explanation also indicates that it is possible that the photopigments normally contained in M and L cones switch.

The opponent process theory holds that if the difference in the activation of the M cones from that of L cones is positive, then the visual system encodes physical red; if the difference is negative, it encodes physical green.

A switch in photopigments between M cones and L cones would have the following result. Objects that had activated these cones such that the difference was positive before the switch would activate these cones such that the difference was negative after it.

Nida-Rumelin claims that if positive values encode red and negative values encode green, then the colors that objects would look would also switch (1996, p. 148).

Boynton makes the same claim: "[s]uch an observer [with inverted pigments] would be expected to have normal color vision except that the sensations of red and green would be reversed--something that would be difficult, if not impossible, to prove" (1979, p. 358). This condition is called pseudonormal vision (Boynton, 1979, p. 356). Thus, Nida-Rumelin concludes, empirical research indicates that spectrum inversion is possible (1996, pp. 147-148).

Without disputing the possible occurrence of a switch in photopigments between M and L cones, the claim that such a switch would be a case of spectrum inversion is

objectionable.

Nida-Rumelin holds that positive values resulting from the difference in activation of M cones from that of L cones encodes red regardless of the physical properties of objects seen. Thus, she assumes that whether a physical object is experienced as red or green isn't determined at all by physical properties of objects.

This assumption conflicts with the following possibility. In normal visual systems, the property physical red is encoded by a positive value resulting from the difference in activation of M cones from that of L cones. In visual systems where the photopigments contained in M cones and L cones are switched, physical red is encoded by a negative value resulting from the difference in activation of M cones from that of L cones.

In this case, identity of neural state isn't sufficient for identity of experienced color. Objects look red because they have a particular physical property, which may be encoded by the visual system in more than one way. If mental red can be realized by the encoding of either positive values or negative values, then Nida-Rumelin's case doesn't demonstrate that the colors that physical objects look switches.

Nida-Rumelin does consider this objection. But she holds that the possibility that mental red is realized by the encoding of either positive or negative values is simply

ruled out. This possibility ". . . is in conflict with the way the case is described in color vision science" (1996, p. 156, fn. 8).

According to the opponent process theory, a positive value resulting from the difference in activation of M cones from that of L cones encodes physical red. But the opponent process theory doesn't go so far as to hold that what it is to experience physical objects as red just consists in excitation of the red-green channel (along with base rate activity of the yellow-blue channel). Rather than provide empirical support for the assumption that identity of neural state is sufficient for identity of experienced color, Nida-Rumelin just asserts that this assumption is part of the opponent process theory.

Setting aside the issue of whether it really is part of the opponent process theory, the assumption that identity of neural state is sufficient for identity of experienced color, and thus that physical properties of objects are irrelevant to experienced color, is a strong assumption. This assumption requires argument, either empirical or philosophical. Simply stating the empirical scientists make the assumption doesn't constitute an argument. Thus, Nida-Rumelin provides no support for this assumption.

#### 4.2.2.2.3. Individual Differences in What's Seen as Unique Green

Clark provides considerations that suggest that the assumption that identity of neural state is sufficient for identity of experienced color is correct. He points out that the same physical property can look slightly different shades to different individuals. (That there are differences among individuals in the color a particular physical property looks is also discussed by Hardin [1993a, pp. 78-80]. Hardin presents this psychophysical evidence against the proposal that the colors of objects can be characterized in terms of standard perceivers.)

These differences among individuals can be experimentally proven. In experimental situations, an emitted light identified as unique green, that is, a green that is not at all yellowish or bluish, by one individual may be not be identified as unique green by others. Others might see the light as slightly yellowish green or slightly bluish green (Clark, 1993, p. 165).

Also, the emitted lights that are experienced as unique green differ among individuals (Clark, 1993, p. 165).

Clark doesn't present this psychophysical evidence to support the possibility of spectrum inversion. Rather, he presents it to support the claim that sensory qualities cannot be defined in terms of physical properties of physical objects (1993, p. 170).

But, if this evidence shows that physical properties play no role in determining the color we experience physical objects as having, it can be used to support the possibility of spectrum inversion. (This evidence can also be used to support the claim that the colors we are aware of in visual experience are mental colors, where mental colors aren't qualia but rather are properties of neural states.)

Furthermore, this psychophysical evidence is important because it doesn't rely on assuming supervenience of experienced color on neural states. Rather, this evidence straightforwardly presents conditions where a physical property produces different experiences of color among perceivers. The question as to whether these differences in experiences of color is sufficient for differences in neural states is then posed rather than simply taken for granted.

If differences in visual experiences of color cannot be explained in terms of differences in physical properties of objects, but rather can only be explained in terms of neural differences, then the claim about supervenience is supported. Moreover, it seems that the slight differences in the colors experienced cannot be explained in terms of differences in the physical properties of physical objects.

The qualitative similarity relations among colors are nearly identical in human perceivers with normal visual systems (Clark, 1993, pp. 175-179). This similarity among perceivers in terms of their visual systems makes their

color experiences comparable. Experience of color can be described in terms of qualitative similarity relations--as, for example, unique green is described. Thus, the psychophysical evidence shows that for different individuals, the experiences of color caused by a physical property can be described in terms of different points in the same psychological color space.

There's a parallel between the example of individual differences in the physical properties that produce experiences of unique green and Block's so-called Inverted Earth thought experiment. (Block uses the Inverted Earth thought experiment to argue that perceptual experiences have qualia. Although he doesn't take up the problem of the nature of physical color, he's clear that the colors of objects are not defined in terms of qualia [1990, pp. 55-57].)

Block describes as possible a planet physically and functionally identical to Earth but for the fact that on this other planet, called Inverted Earth, the physical colors of physical objects and processes (including the sky and lightning) are inverted (1990, pp. 62-63). Thus, grass is physical red. Also, the reference of color terms are inverted. Thus, grass is referred to as green. Block proposes:

A team of mad scientists knock you out. While you are out cold, they insert color inverting lenses in your eyes, and change the your body pigment so you don't

have a nasty shock when you wake up and look at your feet. They transport you to Inverted Earth, where you are substituted for a counterpart who has occupied a niche on Inverted Earth that corresponds exactly (except for the colors of things) with your niche at home (p. 63).

When the transported person awakes on Inverted Earth, the colors of physical objects look normal to him, even though the colors of objects are inverted, due to the inverting lenses. For the inverting lenses have the effect of inverting what it's like to experience the physical colors of physical objects. Thus, due to inverting lenses, an object that is physical red is seen as green, that is, green describes what it's like to experience physical objects with this physical property (1990, p. 63).

Furthermore, due to the inversion of the reference of color terms, the inversion of the colors of objects on Inverted Earth is undetectable (independently of scientific investigation). The person from Earth and the people who live on Inverted Earth call the same objects green. This is all despite the fact that on Inverted Earth what are called green objects are physical red and the people on Inverted Earth see them as red. The person from Earth sees them as green and calls them green due to the inverting lenses (1990, pp. 62-63).

But why believe that the person transported to Inverted Earth does see physical red as green? How do we determine what color this person experiences physical objects with

physical red as having? The only answer that Block provides is that experienced color supervenes on neural states.

According to the thought experiment, when the person from Earth looks at something that is physical green on Earth, for example, grass, it produces neural state S, and he sees it as green. Then this person has inverting lenses placed in his eyes and is transported to Inverted Earth. Block holds that, due to the inverting lenses, when this person looks at something that is physical red on Inverted Earth, for example, grass, it also produces neural state S, and he sees it as green (1990, p. 63; pp. 65-66; p. 68).

Block concludes from the thought experiment that it's possible that the same experienced color can be caused by objects with inverted physical colors (1990, p. 67). However, the basis for believing that experienced color is the same, even when visual experiences are produced by objects with different physical colors, is the claim that identity of neural state is sufficient for identity of experienced color.

As Clark's descriptions of psychophysical findings show, one needn't resort to elaborate thought experiments to suggest that there could be differences among individuals with respect to the colors they see physical objects as having. Experiments show that the physical properties that are experienced as unique green differ among individuals.

Moreover, in psychophysical experiments evidence for

identity of experienced color doesn't rest on supervenience, but rather classification of visual experience of color in terms of qualitative similarity relations. Experiences of color are qualitatively type identical if they can be described in terms of the same point in the psychological color space. For example, experiences of unique green are characterized as experiences of a green that is not at all yellowish or bluish.

Also, identity of qualitative similarity relations among experienced colors is explained in terms of identity of properties of neural processes. Thus, the psychophysical findings are more compelling than Block's thought experiment. Rather than assume supervenience of experienced color on neural states, these findings give us independent reason to believe that identity of neural properties is sufficient for identity of the color we experience physical objects as having.

How do we explain the subtle differences in experiences of color described in psychophysical findings? Are they explained only in terms of neural differences?

There are two types of factors that explain intersubjective differences in colors we experience physical objects as having. One type of factor involves the filtering of light by parts of the eye before light reaches the cones. Light is filtered by the yellow pigment of the lens, which yellows over time, and the macula, which is part

of the central area of the retina (Hurvich, 1981, pp. 113-116).

However, the intersubjective differences in experienced colors which are produced by the light filtering effects of the lens and the macula are uninteresting. Intersubjective differences produced by such light filtering effects are no different in kind from intersubjective differences produced the light filtering effects of sunglasses. Moreover, Hurvich claims, "[s]ince [the yellow pigment of the macula] varies in amount from one individual to the next, it accounts for a large amount of the interobserver variability in making [spectral color matches]" (1981, p. 116).

But Hurvich points out another factor that accounts for intersubjective differences. There are differences among individuals in the absorption spectra of their three cone types. The absorption spectra of a given cone type is represented by a graph that shows the amount of light absorbed by the cone relative to the amount of light incident for each wavelength of light.

Absorption spectra for the three types of human cones are represented by three overlapping bell-shaped curves, each of which span large parts of the visible spectrum (Hurvich, 1981, p. 130). Since absorption of light is directly proportional to activation of the cones, the wavelength for which a cone has peak absorption is that for which it has peak activation (Hurvich, 1981, pp. 117-118;

Boynton, 1979, pp. 259-260).

The three cones types have peak absorption at different places in the spectrum. The three types of cones have peak absorption at similar places, S cones around 420, M cones around 531, and L cones around 558, for standard human perceivers (Gouras, 1985, p. 385).

But there are slight variations in the absorption spectra of the cones among standard human color perceivers (Hurvich, 1981, pp. 222-223; Hardin, 1993a, pp. 78-80). There are even greater variations between standard human perceivers and nonstandard human perceivers called anomalous trichromats. For some anomalous trichromats, each of the three cones have peak absorption at locations shifted along the spectrum in comparison with normal human perceivers (Hurvich, 1981, pp. 229-230). (Anomalous trichromacy is a general classification, and applies to a variety of subgroups of abnormality. Some of these abnormalities are associated with shifts in the peak absorptions of cones, others are associated with abnormally low responsiveness of the opponent channels [Hurvich, 1981, pp. 226-233].)

Due to differences among individuals in the absorption spectra of their cones, different physical properties will produce the particular ratio of activation of the cones which is associated with unique green. (Variations in the absorption spectra between standard human perceivers and anomalous trichromats, while greater than variations among

standard human perceivers, still result in fairly subtle differences in the colors physical objects are experienced as having. For example, due to such variations a physical object might be seen as unique green by a nonanomalous trichromat and a yellowish green by an anomalous trichromat [Hardin, 1993a, p. 78].)

Thus, differences in absorption spectra, along with the light filtering effects of the lens and the macula, explain why the emitted lights that are experienced as unique green differ among individuals. (See Boynton, 1979, p. 384, and Hilbert, 1987, p. 97, who also account for individual differences in terms of differences in absorption spectra and the light filtering effects of the lens and the macula.)

The explanation of intersubjective differences in experienced color in terms of differences among individuals in the absorption spectra of their cones suggests that experienced color does supervene on neural states. This explanation of intersubjective differences suggests that experienced color is determined only by the activation of the cones, and the gauging of this activation by the opponent channels, not by the physical properties of objects. Physical properties of objects seem to be irrelevant in determining the colors we see physical objects as having.

However, it's not clear that physical properties of objects are irrelevant. By drawing a distinction between a

proposal about the nature of color and a theory of color perception, we can see that the following is possible.

The colors we experience physical objects as having are physical properties. A psychological theory of color perception describes our access to colors, whatever their natures happen to be. Such a theory also indicates how our access to the properties that are colors differs among individuals due to differences among our visual systems.

A psychological theory of color perception would indicate that due to differences among individuals in their absorption spectra, individuals have different access to physical colors. If a physical property produces different experienced colors among individuals, this difference is explained in terms of different access to physical colors. Due to differences in absorption spectra, different individuals are prevented from experiencing the same physical property as the same shade.

A psychological theory of color perception also explains the following difference in access to physical colors. A shift in absorption spectra of the cones can be created in a normal perceiver by color adaptation (Clark, 1993, p. 44). Color adaptation is the effect of the bleaching of cone pigments due to intense exposure to a color. Since the cones are differentially sensitive to colors, the exposure will bleach certain cone pigments more than others. But the result will be a shift of the

absorption spectra of all of the cones to a greater or lesser degree (Hurvich, pp. 199-202).

Individuals who have different cone absorption spectra, and thus who experience different physical properties as unique green, can nevertheless come to experience the same physical property as unique green by differential adaptation. In this way these individuals, who have different access to physical colors in standard conditions come to have the same access to physical colors.

Vision is the only perceptual modality that is directly sensitive to physical colors. How do we tell whether individual differences with respect to the physical properties that produce experience of unique green are differences in physical color as opposed to differences in access to physical color? If we rule out that colors are monadic physical properties of physical objects, and thus properties to which we also have indirect access, it seems that we simply can't tell.

As far as individual differences indicate, identity of neural state is compatible with difference in experienced color. Thus, as far as individual differences indicate, physical colors are relevant in determining the colors we experience physical objects as having.

(Alex Byrne and David Hilbert also offer a physicalist response to this problem. They hold that individual differences indicate that "some ways of being unique green

are also ways of being bluish green" [forthcoming b, p. 19]. But they deny that unique green and bluish green are the same property. I think the only way to understand their claim is by distinguishing a psychological theory of color perception and physical colors, and point to individual differences in perceptual access to physical colors.)

Since there are individual differences with respect to the colors physical objects are experienced as having, according to which perceiver is the nature of physical color specified?

In chapter 3, I claim that ordinarily perceivers are specified as standard human perceivers, namely, nonanomalous trichromats. Since there are individual differences with respect to the physical properties that are experienced as unique green, even among nonanomalous trichromats, our ordinary color terms don't refer to points in the psychological colors space, but rather regions.

I conclude that arguments for dispositionalism provide no reason to believe a weak version of the epistemological constraint on the nature of color, according to which our ordinary experience of color provides access to at least an aspect of the nature of colors. Having determined that neither Johnston's nor Peacocke's arguments are successful, I conclude there's no epistemological argument for holding that descriptions of physical colors in terms of our ordinary experience of color provides a specification of the

nature of color.

Although we describe physical colors in terms of visual experiences with mental colors, such descriptions merely serve to fix the reference of color terms. In this case, the relation between visual experiences of color and physical colors is epistemological, not constitutive.

Thompson also offers a proposal about the nature of colors according to which the colors of objects are relations between properties of perceivers and objects. Since Thompson rejects a characterization of visual experiences in terms of qualia, he distinguishes his proposal from the dispositionalist proposals that I have been considering.

Also, Thompson's argument for his proposal isn't epistemological. Rather, he argues for this proposal on the basis of scientific research on the color vision of different animal species. In the next chapter, I'll examine Thompson's argument.

### 5. Thompson's Comparative Argument

In his book Colour Vision: A Study in Cognitive Science and the Philosophy of Perception (1995a), Thompson presents empirical results from comparative studies of the visual systems of different animal species to establish the claim that colors are constituted by relations between properties of perceivers and objects. His argument for a relational proposal about the nature of color is important not only because it draws from empirical study of color vision. But also because it provides an examination of scientific research from a range of scientific disciplines which are relevant to any proposal about the nature of color.

Thompson points out that proposals about the nature of color which are supported by findings from visual science typically make use of results from only certain segments of the range of disciplines which constitute visual science. Thus, physicalism about color, as it is proposed by Hilbert (1987, 1992) and Matthen (1988), is motivated primarily by findings in computational vision. Subjectivism, as it is proposed by Hardin (1993a) and McGilvray (1994), is motivated primarily by findings in psychophysics and neurophysiology.

By contrast, Thompson's proposal about the nature of

color focuses on results from comparative color vision, an interdisciplinary field that studies the color vision of different animal species. Comparative color vision examines differences in the visual systems of different species with respect to anatomy, neurophysiology, psychophysics, evolutionary history, and ecology. By attending to the results of these different fields, Thompson provides an account of the relation between the color perceiver and colored objects perceived from a broader scientific perspective.

On the basis of evidence from comparative color vision, Thompson concludes that different species have different color categories, that is, different categories by which colors are classified as qualitatively identical or different and qualitatively similar or dissimilar. He claims that the differences in visual systems, and thus in color categories, are explained ecologically. This explanation describes perceiver types in relation to their environments in the course of evolution.

Holding that the color categories of a species are determined by ecological relations between members of the species and objects in their environment, Thompson concludes that colors are constituted by relations between properties of perceivers and objects, where perceivers and objects are ecologically described.

Thompson calls this argument, in which he attempts to

establish the claim that colors are relations, the comparative argument. (The comparative argument is also presented in Thompson, Adrian Palacios, and Francisco J. Varela's "Ways of Coloring: Comparative Color Vision as a Case Study for Cognitive Science," [1992].)

I shall examine this argument. In the course of this discussion, I'll consider what color vision is, such that we can attribute perceptual states of color to other species. I'll also examine Thompson's account of what it means to attribute color categories different from our own to other species.

Finally, although Thompson gives good reasons to hold that color categories are determined in part by ecological relations, I reject Thompson's conclusion that colors are relations. The proposal that colors of objects are monadic physical properties is consistent with the claim that color categories are determined by ecological relations and thus differ among species. I'll argue that by distinguishing between mental colors, which determine color categories, and physical colors, the properties of objects which are categorized, we can admit that color categories are determined by ecological relations without accepting that the colors of objects are themselves relations.

### 5.1. The Comparative Argument

Studies of comparative color vision indicate that other species, including bees, goldfish, and pigeons, have color vision. These studies show that other species have visual systems that differ from standard human visual systems with respect to number of types of light-sensitive retinal cells, or cones. Standard human visual systems have three types of cones, and thus are trichromats. Some other species, such as goldfish and pigeons, have greater numbers of types of cones. Also, other species, such as bees, are trichromats, but have cones that are sensitive to different parts of the spectrum than our cones. These neurophysiological differences suggest that other species categorize colors differently than we do.

For example, comparative studies indicate that the visual systems of other species can discriminate among wavelengths in parts of the spectrum where we can't. For example, other species can discriminate wavelengths into the ultraviolet and infrared (Thompson, 1995a, pp. 146-147). Also, comparative studies suggest that other species also categorize colors differently than we do, even within the range of the spectrum visible to us. Categorizations differ with respect to the wavelengths categorized as same or different in hue (Thompson, 1995a, p. 176; Thompson, Palacios, and Varela, 1992, p. 13), and perhaps even with respect to qualitative similarity relations (Thompson,

1995a, pp. 151-157).

Furthermore, comparative studies indicate that the visual systems of other species have evolved to perform biological functions which can be described in biological and ecological terms. To illustrate, it has been proposed that one of several biological functions of color vision is to promote detection of objects against backgrounds, for example, fruit against surrounding foliage.

Thus, comparative studies indicate that the proposal, offered, for example, by Hilbert and Matthen, to describe the biological function of color vision in terms of detecting a particular range of physical properties, namely reflectance properties of surfaces, misdescribe the biological function of color vision. According to Hilbert and Matthen, because the biological function of color vision is to detect reflectance properties, no range of physical properties other than reflectance properties can be identified with physical color.

(Biological functions are described teleologically. In the context of arguing for physicalism, Matthen's notion of biological function is a modification of that proposed by Larry Wright [Matthen, 1988, p. 15, referring to Wright, 1973]. Hilbert doesn't specify what notion of biological function he uses, but cites Matthen's use of biological function to characterize perceptual states as being a similar proposal [1992, p. 369, fn. 12]. Thompson seems to

go along with Matthen's and Hilbert's notion of biological function.)

If comparative studies indicate, to the contrary, that a description of the biological function of color vision in nonphysical terms is motivated, any and all ranges of physical properties that produce perceptual states of color can be identified with physical colors. For example, the range of physical properties of the sky that produce perceptual states of color can be physical colors (Thompson, 1995a, pp. 102-103, pp. 182-183; Thompson, Palacios, and Varela, 1992, pp. 17-18).

Drawing from the results of comparative studies, Thompson argues the physicalism cannot account for differences among species with regard to color categorizations. He also argues that if physicalism relies on a description of the biological function of color vision in terms of detecting reflectance properties, then comparative studies indicate that physicalism is false.

I'll show that considerations raised by comparative studies about the biological function of color vision only tell against a version of physicalism, namely, that version proposed by Hilbert and Matthen. In the next section, I'll describe this version of physicalism and Hilbert's argument for it. Then I'll set out Thompson's argument against it.

### 5.1.1. Comparative Studies and Nondisjunctive Physicalism

Thompson argues against physicalism on the basis of considerations about the biological function of color vision. This argument specifically targets Hilbert's and Matthen's version of physicalism. For purposes of describing this version of physicalism, I'll focus primarily on Hilbert's view.

Hilbert draws the following distinction between physical colors and perceived colors. Perceived colors are the colors we are aware of in visual perception of colored physical objects. Due to metamerism, the same shade of perceived color can be produced by indefinitely many distinct reflectance properties.

Physical colors are reflectance properties; a difference in reflectance property is a difference in physical color. Since perceived colors are produced by indefinitely many different physical colors, perceived colors are indeterminate with respect to physical colors (1987, pp. 84-85, p. 102).

Since Hilbert claims that physical colors are nondisjunctive reflectance properties, I'll call his version of physicalism nondisjunctive physicalism.

#### 5.1.1.1. Hilbert's Description of the Biological Function of Color Vision

As Thompson holds (1995a, p. 116), Hilbert motivates nondisjunctive physicalism by citing results from

computational vision (Hilbert, 1987, pp. 126-131 and 1992, pp. 364-365). According to computational vision, vision involves the processing of information contained in representations that encode physical information about the world, such as the reflectance properties of the surfaces of objects.

Hilbert argues that color constancy shows that the biological function of color vision is to detect reflectance properties. Color constancy is the effect in which the color a physical object looks remains fairly constant despite differences in the intensity or wavelength composition of the light illuminating the object. (Hilbert typically describes the biological function of color vision the detection reflectance properties. But, as Matthen states [1988, pp. 23-25], the biological function of color vision is to detect reflectance properties as a means to detect the surfaces of objects.)

Hilbert cites an experiment by Edwin H. Land in which two identical surfaces composed of colored rectangles (a so-called color Mondrian) are each illuminated by a set of three projectors with color filters, each set comprised of projectors with narrowband longwave, middlewave, and shortwave filters. The lights of each of the projectors is adjustable for intensity.

In the experiment, Land measured the light reflected from a given colored patch, for example a green patch, in

one Mondrian. He then adjusted the intensities of the three lights illuminating the other Mondrian such that the light reflected from a differently colored patch, for example, a white patch, would match in wavelength composition and intensity of the light reflected from the green patch.

Nevertheless, the white patch continued to look white. Furthermore, Land showed that he could adjust the lights so that the light reflected from a patch of any color would match the light reflected from the green patch, and the perceived color of that patch would not be green but rather remain constant (Hilbert, 1987, pp. 62-64; the experiment is described in Land, 1977).

The experiment shows that the perceived color of a surface can remain constant despite changes in the intensity and wavelength composition of the light illuminating, and thus reflected by, the surface. It demonstrates color constancy, and thus shows that the physical properties that correlate with perceived colors are reflectance properties of surfaces rather than physical properties of reflected light (Hilbert, 1987, pp. 61-65). (Although, as Thompson points out, simultaneous contrast effects don't correlate with reflectance [1995a, pp. 127-128]. Hilbert, 1987, p. 87, fn. 6, p. 111, fn. 8, admits this point.)

A focus of research in computational color vision is the problem of how a visual system achieves color constancy. Computational color vision approaches the problem by

considering how the visual system processes representations that encode physical information about the light effecting it. The problem is how a visual system detects reflectance, which is a ratio of reflected light to incident light by encoding only the light effecting it, namely, reflected light.

In order to detect the reflectance of a surface, it would seem that the visual system would also have to know the wavelength composition and intensity of the incident light. Various theories have been proposed to solve this problem (see, for example, Land's retinex theory [1977, 1983], and Laurence T. Maloney and Brian A. Wandell's theory which takes the linear models framework approach [Maloney and Wandell, 1986; Maloney, 1986]).

Since color constancy shows that the physical properties that correlate with perceived colors are reflectance properties of surfaces, some computational vision theorists assume that the biological function of color vision is to detect reflectance properties (see, for example, Maloney and Wandell, 1986, who make this assumption). (But not all computational vision theorists accept that the biological function of color vision can be described solely in terms of detecting surface reflectance. See, for example, Anya Hurlbert, 1992, pp. 39-40, James L. Dannemiller, 1992, pp. 33-34, and Adam Reeves, 1992, pp. 49-50).

However, according to Thompson comparative color vision indicates that there are nonhuman species with color vision, and that for these species the function of color vision cannot be described merely in terms of detecting object surfaces by way of reflectance properties. To the contrary, color vision in other species seems to function to detect not just object surfaces by way of reflectance, but also, for example, the time of day and weather conditions by way of properties of the sky which produce perceptual states of color (Thompson, 1995a, pp. 182-183, p. 197).

Thus, if a theorist taking the computational approach assumes that the function of color vision is to detect reflectance properties of surfaces, comparative studies provide a challenge to this assumption. Furthermore, since Hilbert motivates nondisjunctive physicalism primarily by appealing to computational studies that make this assumption, comparative studies provide a challenge to Hilbert's argument for nondisjunctive physicalism.

(Hilbert provides a number of arguments for nondisjunctive physicalism. In this section, I shall consider an argument he gives in response to the challenge provided by comparative color vision.<sup>1</sup> In chapter 3, I describe another argument he offers to support

---

<sup>1</sup> Hilbert's response is to Thompson, Palacios, and Varela (1992), which presents many of arguments against nondisjunctive physicalism also presented in Thompson's Colour Vision (1995a).

nondisjunctive physicalism, which involves rejecting a characterization of physical colors in terms of standard viewing conditions. This argument is independent of considerations about the biological function of color vision.)

Hilbert sets up the dispute between physicalism and the findings of comparative color vision in the following way. He claims that "[c]olor objectivism requires that there be some mind-independent property that is color" (1992, p. 358). Furthermore, according to his version of physicalism, physical color is a single range of physical properties such as reflectance properties (1992, p. 352, p. 358). Hilbert claims that the way we determine what single range of physical properties is identified with physical color by considering what range of physical properties it is the biological function of color vision to detect.

However, studies of comparative color vision indicate that there is no such single range of physical properties at all (Hilbert, 1992, p. 352). Hilbert responds to such studies by claiming that in the cases where species seem to have color vision that doesn't function to detect a single range of physical properties, it's questionable whether the species really has color vision at all (Hilbert, 1992, pp. 352-353).

Hilbert claims that the criterion commonly used to determine whether a species has color vision is the ability

to discriminate among stimuli, consisting of emitted lights, by differences in the wavelength composition independently of differences in their intensities (1992, p. 353). Hilbert plausibly argues that mere discrimination among emitted lights due to differences in wavelength composition of isn't sufficient for having color vision (1992, pp. 356-357). (Thompson, 1995a, p. 184, admits that wavelength discrimination is commonly used to determine whether a species has color vision.)

Hilbert suggests adding criteria to wavelength discrimination to determine possession of color vision. The additional criteria he proposes are chromatic contrast effects (such as simultaneous contrast) and qualitative similarity relations among colors (1992, p. 357). He holds that including these criteria is important because chromatic contrast and qualitative similarity relations indicate postreceptoral processing of receptor responses to color, and he claims that postreceptoral processing is necessary for having color vision (1992, p. 357).

(Thompson's conditions for having color vision are very similar to Hilbert's proposed criteria, 1995a, p. 145; these conditions are also presented in Thompson, Palacios, and Varela, 1992, p. 14. Thompson prefers to characterize color vision in terms of necessary conditions, while Hilbert prefers to characterize color vision in terms of criteria for indicating the possession of color vision. As far as I

can see, nothing turns on this issue.)

Rather than pursue these suggested criteria, Hilbert proposes a criterion for color vision with regard to biological function. He proposes that the biological function of color vision is to detect whatever single range of physical properties are physical colors (1992, p. 362).

But since he also claims that physical colors are whatever physical properties it is the biological function of color vision to detect (1992, p. 363), his proposal isn't informative. He claims that if we can identify color vision in terms independently of physical colors, then we can consider the biological function of the capacity identified in this way, and in turn provide an informative identification of physical colors (1992, p. 363).

Hilbert claims that we can identify color vision in terms independently of physical colors, namely, as that capacity of the visual system which produces visual experiences of color (1992, p. 363). It cannot be objected that this identification of color vision is made in terms of physical colors--after all, according to Hilbert, the perceived colors according to which we classify visual experiences of color are distinct from physical colors. Thus, identifying color vision as the capacity to produce visual experiences of color doesn't beg any questions about the nature of physical color.

Having identified color vision, we can consider what

the biological function of this capacity is. Hilbert asserts that color constancy demonstrates that the function of color vision is to detect the reflectance properties of the surfaces of objects. Thus, on the basis of color constancy, Hilbert claims that the single range of physical properties that are physical colors is the range of reflectance properties (1992, pp. 364-365).

Furthermore, Hilbert asserts that if we admit that the biological function of color vision is to detect reflectance properties, then studies of comparative color vision simply can't refute nondisjunctive physicalism. Any evidence that indicates that other species use a visual capacity to detect physical properties that aren't reflectance properties is evidence that the visual capacity isn't color vision (1992, p. 366).

However, while color constancy provides support for the claim that physical colors are reflectance properties of surfaces, this visual effect doesn't by itself prove this claim. Rather, in order to prove this claim, Hilbert must also show that the biological function of color vision is the detection of a single range of physical properties. Hilbert provides no such argument.

Furthermore, as Thompson claims, there are good reasons to hold that reflectance properties are just one of many ranges of physical properties that it is the biological function of color vision to detect. The important

consideration is whether the biological function of color vision should be described in physical terms or in biological terms.

If the biological function of color vision is to be described in biological terms, for example, in terms of identifying objects against backgrounds, it's very unlikely that color vision functions to detect a single range of physical properties. Although Maloney and Wandell support the assumption that the biological function of color vision is to detect reflectance properties of surfaces, a motivated description of the function of human color vision is precisely what's in question.

Next, I shall describe Thompson's argument for the conclusion that the biological function of color vision should be described in biological and ecological, rather than in physical, terms.

#### 5.1.1.2. Thompson's Alternative Description of the Biological Function of Color Vision

Thompson is aware that there is an issue about determining criteria for color vision (Thompson, 1995a, pp. 141-145, pp. 263-286; Thompson, Palacios, and Varela, 1992, pp. 13-15). How exactly are we describing bees if we say that they have color vision?

Thompson offers the following conditions as necessary and jointly sufficient for possessing color vision: wavelength discrimination, namely, the ability to

discriminate among emitted lights by differences in the wavelength composition of the lights independently of differences in their intensities; the ability to additively mix colors; the ability to have simultaneous and successive color contrast effects; and the achievement of color constancy (Thompson, 1995a, p. 145; these conditions are proposed only as necessary conditions in Thompson, Palacios, and Varela, 1992, p. 14).

Thompson cites studies that indicate that other species meet these conditions for having color vision. He cites studies by C. Neumeyer (1980, 1981) and A. Werner, R. Menzel, and C. Wehrhahn (1988) of vision in bees which indicate that bees demonstrate wavelength discrimination, simultaneous and successive color contrast, and color constancy (Thompson, 1995a, pp. 176-177; Thompson, Palacios, and Varela, 1992, p. 15).

He refers to studies by Francisco J. Varela, Adrian Palacios, and T. H. Goldsmith (1993) of vision in pigeons which indicate that these species demonstrate color constancy (Thompson, 1995a, p. 312, fn. 13). He also cites a study by Anthony A. Wright and William W. Cumming (1971) which suggests that pigeons group spectral lights that are adjacent in wavelength into color categories (Thompson, 1995a, p. 312, fn. 13). (Hardin also refers Wright and Cumming's study of pigeons [1993a, pp. 152-154], and to a study by Menzel [1979] which indicates that bees demonstrate

simultaneous contrast.)

Concluding that other species have color vision, Thompson then claims that for these other species the biological function of color vision is not only surface detection by way of reflectance properties. For example, citing J. F. W. Nuboer (1986), Thompson hypothesizes that for pigeons, color vision functions to detect properties of the sun's illumination for aerial navigation (Thompson, 1995a, p. 182; Thompson, Palacios, and Varela, 1992, p. 18). Referring to H. W. van der Glas (1980), Thompson suggests that bees also detect properties of atmospheric light for navigation (1995a, p. 182).

However, in a different context Thompson indicates that detection by bees of properties of atmospheric light for navigation does not meet his own conditions for having color vision. Thompson points out that when bees detect properties of atmospheric light for navigation, they demonstrate what's called a wavelength-dependent behavior. Such behaviors are "highly specific behavioral routines, such as escape, feeding, egg-laying, etc." (1995a, p. 143) which are triggered by properties of light.

Thompson holds that wavelength-dependent behaviors are generally not used as evidence for color vision, in part because such behaviors are initiated by receptor responses that probably aren't encoded by postreceptor processes-- the processes that explain, for example, simultaneous and

successive color contrast (1995a, p. 143). (See Hilbert, 1992, p. 357, who also holds that postreceptoral processing of receptor responses to color is necessary for having color vision.)

Thompson's consideration of comparative studies do suggest that other species have color vision and that the biological function of color vision for these other species is not only to detect reflectance properties. However, as the case of bees illustrates, we must be careful in attributing color vision to other species.

Bees have color vision according to Thompson's conditions for having color vision, but, as Thompson's own discussion reveals, bees meet these conditions only when detecting surfaces by reflectance properties. In the context of detecting properties of atmospheric light for navigation, bees don't meet the conditions for color vision (Thompson, 1995a, p. 143, p. 182).

Thompson primarily supports the claim that the biological function of color vision isn't just to detect reflectance properties by way of empirical studies of species that putatively have color vision, and that seem to use color vision to detect properties other than reflectance properties (Thompson, Palacios, and Varela, 1992, p. 62). However, he also argues that the function of human color vision is not simply to detect reflectance properties (1995a, p. 182, p. 189; Thompson, Palacios, and Varela,

1992, p. 62). Thus, we can avoid the issue of whether a nonhuman visual capacity for detecting properties other than reflectance really is color vision.

Considering the biological function of color vision in human beings and other primates, Thompson rejects Hilbert's description of the function of color vision in physical terms. Thompson offers an alternative description in biological and ecological terms.

Thompson describes a number of biological functions of primate color vision which are set out by J. D. Mollon (1989) (Thompson, 1995a, p. 175, p. 182, pp. 195-196).

Mollon proposes that the biological functions of primate color vision include promoting the detection of objects, for example, the detection of fruit against a background of foliage; the segmentation of the field of view into distinct objects by grouping together the perceptible properties of objects, for example, grouping together perceptible properties of a leaf as properties of an object distinct from surrounding leaves; and the identification of objects as of a particular type, for example, as a fruit, and identification of the state of perceived objects, for example, the state of ripeness of fruits (Mollon, 1989). (Clearly, object detection and identification, and segmentation of the field of view require perceptual and cognitive capacities in addition to color vision. The claim is that color vision serves to promote these tasks.)

Mollon motivates this description of the biological function of color vision by considering the advantages of human trichromacy compared to dichromacy. (Dichromats have only two types of normally functioning cones, and thus cannot make as many discriminations among colors as trichromats.) Compared to trichromats, dichromats have difficulty in detecting objects and identifying the states of objects, and segmenting the visual field of view (Thompson, 1995a, p. 175, p. 195).

(G. H. Jacobs [1981] gives the following similar description of the biological function of color vision: color vision promotes object detection against a background, recognition of an object as a certain kind, for example, as a fruit, and identification of the states of objects, such as ripeness. This description is motivated by considering the advantages of chromatic vision compared to achromatic vision. Gary Hatfield, 1988, p. 498, and Hardin, 1992, p. 372, refer to Jacobs's description of the biological function of color vision.)

As Thompson points out, reflectance properties of surfaces are important in detecting objects and identifying their states and in segmenting fields of view (p. 312, fn. 15). But Hilbert's claim that the biological function of color vision is to detect reflectance properties serves to support the claim that reflectance properties are physical colors. Thus, according to Hilbert's claim about the nature

of physical color, the sky on a sunny day isn't blue because the sky doesn't have reflectance properties. (See Matthen, 1988, p. 25, who explicitly denies that the sky is blue because the sky doesn't have reflectance properties.)

Since Mollon's description of the biological function of color vision is put in nonphysical terms, it doesn't play favorites with respect to any range of physical properties. Physical colors aren't limited to the range of reflectance properties, but also include properties of various distinct ranges of physical properties. In this case, we needn't deny, for example, that the sky has color because the sky doesn't have a surface. The physical properties of the sky which produce visual experiences of color can also be physical colors.

Hatfield, in his elegant article, "Color Perception and Neural Encoding: Does Metameric Matching Entail a Loss of Information?" (1988), also rejects Hilbert's description of the function of color vision in physical terms.

If we describe the biological function of color vision as the detection of reflectance properties, then metamerism marks a failure of the visual system. Due to metamerism, distinct reflectance properties can look the same shade of color.

However, if the biological function of color vision isn't best described as the detection of reflectance properties, but rather as, for example, the detection

objects by properties that make them stand out against a background, then it doesn't follow that metamerism is a failure.

The task of discriminating fruit from surrounding foliage isn't hampered by metamerism. Hatfield states,

[i]ndeed, it might well be an advantage if classes of surfaces that were biologically equivalent in relation to a given organism appeared to be of the same color to that organism, despite spectrophotometric variations in surface-reflectance properties (an advantage consisting in fewer irrelevant differences among sensory representations) (pp. 497-498).

Rather, if the biological function of color vision includes detecting objects, and identifying objects and their states, then these functions are better served by perceived colors than reflectance properties. For perceived colors can be grouped into a small number of broad categories. These broad categories include starkly contrasting pairs, in particular, red and green and yellow and blue (Hatfield, 1988, p. 500-501; see also Hardin, 1992, pp. 379-381 and Thompson, 1995a, pp. 196-198, who make this point).

Hatfield claims, "[j]udgments of function must be tested by taking the animal/environment relation into account. Only by learning how sensory systems actually are used can we determine what they are for" (p. 501). He cites a study by W. N. McFarland and F. W. Munz (1975) of the relation between environmental conditions and cone types in tropical fish which indicates that color vision in these

fish has evolved to promote detection of objects against backgrounds in underwater environments (1992, p. 501).

Thompson cites other studies of fish, as well as studies of color vision in other species, which indicate that color vision has evolved to promote ecologically-described functions, such as detection of objects against backgrounds (1995a, pp. 168-175; Thompson, Palacios, and Varela, 1992, p. 18).

These considerations tell against a description of the biological function of color vision in physical terms. Such a description relies on regarding the visual system as a physical instrument designed to detect and record physical differences (Hatfield, 1988, pp. 495-496).

(Hatfield also concludes that physical colors are relations between physical properties of objects, such as reflectance properties, and perceivers [1992, p. 498]. Unfortunately, he provides no argument for holding that colors are relations rather than disjunctive nonrelational physical properties of objects merely identified with relation to perceivers.)

If the biological function of color vision is not described in physical terms, and so is not described as the detection of reflectance properties, then there's no reason to hold that physical color is a single range of physical properties, such as reflectance properties.

Furthermore, if we describe the biological function of

color vision in biological and ecological terms, then if a species meets Thompson's conditions for having color vision, we have no reason to deny that a species has color vision even if it uses color vision to detect properties other than reflectance properties. To the contrary, as Thompson argues, comparative studies support the claim that color vision functions to detect many ranges of physical properties. (Also see Kathleen A. Akins and John Lamping, 1992, p. 26, who support the claim that other species use color vision to identify nonsurface properties.)

Hilbert provides no reason to accept a description of the biological function of color vision in physical terms, and thus reject a description in biological and ecological terms. If we go along with Mollon's or Jacob's description, the claim that physical colors are a single range of physical properties is simply implausible.

However, nondisjunctive physicalism is only one version of physicalism. According to the other main version of physicalism, which I'll call disjunctive physicalism, physical colors are a disjunction of physical properties. The disjunction of physical properties identified as a shade of red includes not only metameric reflectance properties, but also physical properties other than reflectance properties. Because disjunctive physicalism allows that physical colors include a disjunction of ranges of physical properties, comparative studies along with considerations

about the biological function of color vision do not defeat this view.

But comparative studies seem to provide other grounds on which to reject any version of physicalism, including disjunctive physicalism. Comparative studies suggest that other species categorize colors differently than we do. In the next section, I shall consider how such different color categorizations can be described and whether they pose a problem for disjunctive physicalism.

#### 5.1.2. Comparative Studies and Varieties of Psychological Color Space

Thompson's comparative argument relies on comparative studies to support the claim that colors are relations between properties of perceivers and objects. As I've just described, comparative studies, along with considerations about the biological function of color vision, indicate that physical colors are not a single range of nondisjunctive monadic physical properties of objects. Nevertheless, since physical colors may be disjunctive monadic physical properties of objects, we cannot yet conclude that the colors of objects are relations.

Thompson claims on the basis of comparative studies that different species have different color categories. Furthermore, he claims that differences in color categories among species are explained by ecological relations. Thompson concludes that colors are constituted by relations

between properties of perceivers and objects, where perceivers and objects are ecologically described (1995a, p. 177, pp. 203-204, pp. 242-245; Thompson, Palacios, and Varela, 1992, p. 23).

(Thompson provides another argument to support the claim that the content of visual experience must be specified in terms of ecological relations. He claims that there are differences among species in what constitutes a surface [1995a, pp. 198-202; Thompson, Palacios, and Varela, pp. 16-17].)

I shall first discuss Thompson's suggestions as to what it means to say that other species have color categories that differ from our color categories. Then I'll consider Thompson's argument from evidence that differences in color categories are explained ecologically to the conclusion that colors are relations between properties of perceivers and objects.

Pivotal to Thompson's claim that different species categorize colors differently is his conjecture that different species have different psychological color spaces. This conjecture is grounded on evidence that different species have different numbers of types of photosensitive cells along with postreceptoral processes that gauge the activation of these cells (Thompson, 1995a, pp. 149-150; Thompson, Palacios, and Varela, pp. 10-13).

This evidence is relevant because the psychological

color space, which represents qualitative similarity relations among perceived colors for human nonanomalous trichromats, is explained in terms of postreceptoral processes which gauge the activation of three types of cones. Thus, Thompson proposes that if other species have, for example, greater numbers of types of photosensitive cells, and postreceptoral processes gauge the activation of these cells, then other species may have different types of psychological color spaces (1995a, pp. 65-67, pp. 145-146, p. 151; Thompson, Palacios, and Varela, 1992, p. 13, p. 56).

Furthermore, the conjecture is supported by evidence that other species categorize objects according to colors (Thompson, 1995a, pp. 176-177, p. 189; Thompson, Palacios, and Varela, 1992, pp. 13-15, p. 58).

Thompson's conjecture is made comprehensible by a proposal of how to describe other types of postreceptoral and psychological color spaces, in particular ones with more dimensions than three. A psychophysical color space is a type of postreceptoral color space which has axes specified in terms of postreceptoral opponent channels. Human trichromats have a three dimensional psychophysical color space, with orthogonal red-green, yellow-blue, and black-white dimensions.

The psychophysical color space is quantitatively specified in terms of inhibition and excitation of psychophysical channels; the psychophysical color space

provides an explanation of the psychological color space, which is specified in terms of qualitative similarity relations among perceived colors (Thompson, 1995a, pp. 66-67, pp. 97-99). (The psychological color space is also described as having three dimensions, namely, dimensions of hue, saturation, and lightness. However, saturation isn't a distinct orthogonal axis in the psychological color space. Rather, saturation is represented in the psychological color space by horizontal distance from the vertical black-white dimension. See Thompson, 1995a, pp. 66-67, pp. 97-99, for a discussion of the relations among different sorts of color spaces.)

Thompson speculates that if an animal that has four types of cones, called a tetrachromat, also has postreceptoral processes that encode the activation of these four types of cones, then this perceiver type has a four-dimensional psychophysical color space. Thus, it's possible that this perceiver type has a psychological color space in which qualitative similarity relations among perceived colors are represented in a four dimensions (Thompson, 1995a, pp. 152-159; Thompson, Palacios, and Varela, 1992, p. 15).

The dimensions to the tetrachromat's psychophysical color space would include three chromatic dimensions and an achromatic dimension, all of which are orthogonal in a four-dimensional space (Thompson, 1995a, p. 151; Thompson,

Palacios, and Varela, 1992, p. 13, p. 15). These four opponent channels might make it possible for the tetrachromat to experience additional unique and binary hues (that is, mixtures of two unique hues), as well as a type of hue which we don't experience at all, namely, ternary hues. Ternary hues are mixtures of three unique hues.

Thus, if these speculations are on the right track, it may be that, due to the different structure of the tetrachromat's psychophysical color space, some of the color categories of tetrachromats, namely the ternary hue categories, are wholly different from our categories (Thompson, 1995a, pp. 158-159, pp. 273-276; Thompson, Palacios, and Varela, 1992, p. 15). (See Hardin, 1993a, p. 146, who provides a similar description of a four-dimensional psychophysical and psychological color spaces.)

Thompson, following Hardin's description, makes it clear how it may be possible that a tetrachromat might experience ternary colors. Thompson admits that whether or not there are tetrachromats that really do have four-dimensional psychological colors spaces is an empirical question as yet unsettled (Thompson, 1995a, p. 158). (With respect to human beings, Thompson points out that there's some evidence that some women are tetrachromats [1995a, pp. 166-168].)

For the sake of argument, I shall accept Thompson's claim that different species categorize colors differently.

How does this claim tell against physicalism?

Thompson appeals to an argument put forward by Hardin, which relies on the metaphysical constraint on the nature of color, namely, the claim that a description of color according to our ordinary experience provides a specification of the nature of color. Thompson holds that monadic physical properties of objects aren't physical colors because these properties don't explain, independent of their relations to perceptual responses, the qualitative similarity relations among colors which are represented in the trichromat's three-dimensional psychological color space (Thompson, 1995a, pp. 123-124, p. 183; Thompson, Palacios, and Varela, 1992, pp. 15-16).

Furthermore, according to Thompson, if there are tetrachromats whose qualitative similarity relations among perceived colors are represented in a four-dimensional psychological color space, then monadic physical properties explain neither the qualitative similarity relations represented in this color space nor the difference between the three-dimensional and the four-dimensional psychological color spaces. An already strong case against physicalism is made even stronger (1995a, pp. 182-183; Thompson, Palacios, and Varela, 1992, p. 16).

In presenting this argument, Thompson takes his physicalist opponents to be Hilbert and Matthen (Thompson, 1995a, pp. 123-124, p. 183, pp. 186-188). If there are

differences among species with respect to color categorization, this would present an objection to Hilbert's and Matthen's claim that physical colors are physical categories, namely, the categories of reflectance properties.

However, since Thompson presents nondisjunctive physicalism as the only physicalist view, he suggests that the plausible claim that color categories aren't physical categories provides an objection to physicalism in general. Thompson claims, "[f]or the externalist [that is, the proponent of the claim that physical colors are monadic physical properties of physical objects], the perceptual content of colour vision is distal because colour is surface reflectance" (1995a, p. 203). Thompson overlooks the possibility that there is a proposal about the nature of physical colors that is alternative to Hilbert's and Matthen's proposal.

According to disjunctive physicalism, even though physical colors are physical properties, physical color categories aren't physical categories. Differences among species with respect to color categorization can be explained in terms of differences in visual systems and visual states.

Nevertheless, Thompson does use the consideration that different species categorize colors differently in an argument that would refute any version of physicalism.

Thompson claims that the differences among species with respect to color categories are explained in terms of ecological relations. According to Thompson, because such differences are explained in terms of ecological relations, the colors of objects are relations between properties of perceivers and objects. In the next section, I shall consider this argument.

### 5.1.3. The Ecological Explanation of Color Categories

Thompson's argument for the claim that the colors of objects are relations between properties of perceivers and objects relies on a theory of perceptual content which he calls the enactive view. According to the enactive view, perceptual states are relations between properties of perceivers and what he calls perceptual objects (Thompson, 1995a, pp. 203-204, pp. 239-246, p. 314, fn. 9; Thompson, Palacios, and Varela, 1992, pp. 22-23).

Thompson holds that perceptual objects are ordinary physical objects. However, properties of perceptual objects, such as colors, aren't categorized physically. Rather, color categories are importantly determined by the perceptual and cognitive systems of perceivers themselves (Thompson, 1995a, pp. 236-250; Thompson, Palacios, and Varela, 1992, pp. 21-24). (In this discussion, color categories include categories by which colors are classified as the same or different, either in terms of determinable or

determinate colors, and those by which colors are classified as qualitatively similar or dissimilar [Thompson, 1995a, pp. 243-246].)

Because color categories aren't physical categories, an object is red only in virtue of its being a perceptual object, and thus, in virtue of its being related to a perceiver that categorizes a disjunction of physical properties as red. Therefore, Thompson claims, nothing is red independently of its being categorized as red by a perceiver (1995a, p. 246).

Furthermore, the enactive view holds that the content of perceptual states include perceptual objects, and the properties of perceptual objects, such as colors, are perceiver-dependent in a metaphysical sense. Thus, according to Thompson, the colors of objects are relations between objects and the perceptual states of perceivers (Thompson, 1995a, pp. 243-246; Thompson, Palacios, and Varela, p. 23). Thompson calls his proposal that colors are perceiver-dependent properties of perceptual objects the ecological view of color (1995a, p. 177).

However, Thompson's argument for the ecological view assumes the metaphysical constraint on the nature of color. He assumes that for a range of properties to be identified with colors, members of the range of properties must be intrinsically related in ways that correspond with the qualitative relations among colors which we're aware of in

ordinary experience.

Thompson also sketches an account of perceiver-dependent properties of perceptual objects, such as colors, in terms of ecological relations between properties of perceivers and objects. Such ecological relations include an extremely complex group of relations between properties of perceivers and objects over the course of a perceiver type's evolutionary history. Thompson calls this account of perceiver-dependent properties of perceptual objects animal-environment codetermination (Thompson, 1995a, pp. 215-220, pp. 236-242; Thompson, Palacios, and Varela, 1992, pp. 19-23, p. 66).

Thompson offers the animal-environment codetermination account of perceiver-dependent properties in support of the enactive view of perceptual content, and in particular, in support of the ecological view of color (Thompson, 1995a, pp. 236-250; Thompson, Palacios, and Varela, pp. 21-23, p. 66). He provides empirical evidence that the color categorizations of a particular species are explained in terms of ecological relations between the species and the objects and processes that make up its environment (Thompson, 1995a, pp. 239-242; Thompson, Palacios, and Varela, 1992, p. 19).

For example, the visual systems of bees allow them to perceive colors in the ultraviolet range of the spectrum. Thompson cites studies by Lythgoe (1979), Menzel (1979),

Barth (1985), and Nuboer (1986) as arguing that the color vision of bees has coevolved with the colors of flowers, which have contrasting colors in the ultraviolet range (Thompson, 1995a, pp. 172-173; Thompson, Palacios, and Varela, 1992, p. 19). Thompson, Palacios, and Varela claim,

On the one hand, flowers attract pollinators by their food content, and so must be conspicuous and yet different from flowers of other species. On the other hand, bees gather food from flowers, and so need to recognize flowers from a distance. This mutual advantage seems to have determined a coevolution of plant features and sensory-neural capacities in the bee (1992, p. 19).

Also, if different species categorize color differently, animal-environment codetermination explains why they do. As Thompson illustrates by many examples from comparative studies, color vision in a species evolves to serve a variety of biological functions in an ecological niche of an environment.

Different species have evolved different types of capacities for color vision, both in terms of numbers of types of cones and in terms of spectral sensitivity of cones, to serve these biological functions in different niches. Differences in types of capacities for color vision go along with differences in color categories (Thompson, 1995a, pp. 160-174; Thompson, Palacios, and Varela, 1992, pp. 18-19).

I accept that, if different species categorize colors differently, Thompson's proposal of animal-environment

coevolution provides a plausible rough account of such differences. Nevertheless, I shall argue that differences among species with respect to color categorization do not show that the colors of objects are relations between properties of perceivers and objects.

### 5.2. The Disjunctive Physicalist's Response to the Comparative Argument

According to disjunctive physicalism, the colors of objects are disjunctions of physical properties of objects categorized by perceived color. This version of physicalism draws a distinction between physical colors and perceived colors which differs from Hilbert's distinction between physical color and perceived colors.

According Hilbert, a difference in reflectance property is a difference in physical color. Perceived colors are the colors of physical objects which we are aware of in visual perception of colored physical objects.

Disjunctive physicalism, by contrast, holds that physical colors are the colors which standard human color perceivers are aware of in standard viewing conditions. Disjunctive physicalism doesn't distinguish between the categories of physical colors and those of perceived colors --physical color categories are the familiar shades of red, green, and so on.

Taking physicalism to be defined in terms of Hilbert's distinction between physical colors and perceived colors,

Thompson holds that any argument that supports that colors categories aren't physical categories provides a refutation of physicalism (Thompson, 1995a, p. 115). (See Hilbert, 1992, p. 358, who also seems to claim that physicalism is defined in terms of his distinction between physical colors and perceived colors.)

Furthermore, Thompson, assuming the metaphysical constraint on the nature of color, holds that if color categories aren't physical categories but rather are importantly determined by properties of the visual systems of perceivers, then colors are relations between properties of perceivers and objects (Thompson, 1995a, p. 134, pp. 203-204, p. 243, pp. 245-246, p. 298; Thompson, Palacios, and Varela, 1992, p. 23). Thompson asserts:

. . . apart from a specification of the perceiver and the viewing conditions there is no fact of the matter about what colours (in either the particular or categorical sense [that is, in either the determinate or determinable sense]) things have (1995a, p. 246).

However, if we draw a distinction between mental color and physical color, we can hold that color categories are explained by mental colors, independently of physical properties of objects. In this case, differences among species with respect to color categorization can be explained in terms of differences in properties of their visual systems and visual states, in particular differences in mental color. These differences can be explained in terms of animal-environment codetermination.

Furthermore, by drawing a distinction between mental color and physical color, the relation between these properties can be characterized as epistemological rather than constitutive. Physical color terms have their references fixed by descriptions of causal relations between physical colors and visual experiences with mental colors. The properties we are aware of in visual experience of color are disjunctive monadic physical properties of objects.

Thompson claims that the colors of objects have both physical and mental aspects--they are relations between perceptual states of perceivers and objects. But, he argues, drawing a distinction between the mental and physical aspects of color, or, as I propose, distinguishing between mental and physical color, commits one to a false distinction between perceivers and objects. He describes this false distinction in terms of what he calls the received view.

According to the received view, physical colors are either physical properties categorized by physical categories or physical properties categorized by color qualia (Thompson, 1995a, p. 32, pp. 36-37, p. 64). Thompson attributes the former view to Hilbert and Matthen, and the latter view to dispositionalism (1995a, pp. 32-33, p. 37).

Also according to the received view, mental colors, for those who accept them, are either qualia experienced as the colors of physical objects or neural states experienced as

the colors of physical objects (Thompson, 1995a, pp. 31-33, p. 36, p. 64). Thompson attributes the former view to dispositionalism, and the latter view to Hardin (1995a, pp. 32-33, pp. 36-37).

However, one can avoid Thompson's objections to the false distinction between perceivers and objects which is incorporated in the received view by simply rejecting the received view's characterizations of physical colors and mental colors. Moreover, my characterizations of physical and mental colors differ from those of the received view. I propose that physical colors are disjunctive physical properties of physical objects which are categorized by mental colors, which are neither qualia nor experienced as the colors of physical objects.

### 5.3. Visual Experience and Perceptible Qualities

According to my proposal, physical colors are monadic physical properties identified by way of reference-fixing descriptions of causal relations among physical colors and mental states of perceivers. With respect to our ordinary color terms, such descriptions specify causal relations between physical colors and standardly mediated visual experiences of actual standard perceivers in actual standard viewing conditions.

Physical colors are monadic physical properties in the sense that perceiver-relative descriptions--descriptions of

the causal relation between physical colors and visual experiences of colors--merely serve to identify physical colors. Physical colors aren't constituted by relations between physical properties of objects and visual experiences with mental colors. However, according to my proposal physical colors are dispositions to modify light in various ways. Reflectance properties, for example, are dispositions to reflect light, and thus are relational properties between physical properties of surfaces and light.

According to my view, a particular shade of red, for example, vivid red, is an indefinitely large disjunction of monadic physical properties identified by visual experiences of vivid red. Physical vivid red is an indefinitely large disjunction of properties of surfaces, flares, and volumes of air, water, and glass. A variety of physical mechanisms, for example, reflection, refraction, scattering, and fluorescence, account for the modification of light such that physical vivid red produces perceptual states of vivid red.

Physical vivid red is, in physical terms, a weird disjunction of physical properties. (See Smart, 1975, pp. 56-58 and Armstrong, 1987, pp. 7-8 for similar proposals about physical colors.)

There are many objections to the claim that physical colors are disjunctions. The vivid red of physical objects

seems to be a paradigm case of a nondisjunctive property. Furthermore, since I've admitted that vivid red is an indefinitely large disjunction, it seems that I've admitted that I really don't know what physical property vivid red is.

That vivid red seems to be nondisjunctive would only indicate that it is nondisjunctive if visual experience of color were to give us access to the nature of color. But there's no reason to hold that visual experience of color does give us access to the nature of color. Thus, that physical colors are physically disjunctive is compatible with the phenomenology of color. (See Smart, 1975, pp. 58-59 and Armstrong, 1987, pp. 9-10 for a similar response. Note that although Armstrong denies that there are disjunctive universals, he accepts that there are disjunctive properties, and he holds that colors are disjunctive properties.)

The explanation for why vivid red is an indefinitely large disjunction is that physical colors are identified by their relations to visual experiences with mental colors. An indefinitely large disjunction of physical properties can produce visual experiences of vivid red.

However, there are causal generalizations of psychophysics, such as the law of trichromacy, which quantify the relations between physical properties of objects and visual experiences. Since such generalizations

account for all of the instances of physical colors, the fact that there are indefinitely many of them isn't worrisome.

Some theorists are suspicious about properties that are identified in terms of their effects (see Richard J. Hall, 1996, p. S128, who explicitly states this suspicion). Although the disjuncts that constitute physical vivid red don't share a common physical property, they do share a common relation to mental vivid red, and this relation isn't haphazard. The relation between physical stimuli and mental effects are storable in causal generalizations such as the law of trichromacy. (As I've discussed, the reference of color terms are fixed in terms of descriptions of standardly mediated visual experiences of colors of standard perceivers in standard viewing conditions, and these descriptions are vague. But this vagueness in the conditions for correct application of color terms doesn't show that the causal relation between mental colors and physical colors is haphazard.)

The suspicion of properties identified in terms of their effects might be founded on the assumption that physical color categories must be physical categories. For if physical color categories are physical categories, then these categories are specifiable independently of the effects of physical colors on any perceivers. In this case, there is a nondisjunctive physical specification of physical

colors.

However, there's no good argument for the assertion that physical color categories are physical categories.

This assertion can be founded on the metaphysical constraint on the nature of color. According to this constraint, no range of properties can be identified with colors unless the members of the range of properties are intrinsically related in ways that correspond with the qualitative relations among colors, which we're aware of in ordinary experience. In this case, for any range of physical properties to be identified with colors, these physical properties must be intrinsically related in ways that correspond with the qualitative relations among color. In this case if physical objects have (nonrelational) physical colors, then physical color categories are physical categories. But there's no good argument for the metaphysical constraint.

Furthermore, Hilbert doesn't successfully argue for the claim that physical color categories are physical categories.

I conclude that physical color categories aren't physical categories, but rather are relative to the visual systems of perceivers. Nevertheless, if we distinguish between physical colors and mental colors, there's no reason to deny that physical colors are monadic physical properties that, described in physical terms, are disjunctive.

### Conclusion

A pair of claims serve to motivate the proposals about the nature of color which I reject. The metaphysical constraint on the nature of color is the claim that a description of colors according to our ordinary experience of color provides a specification of at least some aspects of the nature of color.

The epistemological constraint on the nature of color is the claim that our ordinary experience of color provides access to at least some aspects of the nature of color.

My proposal about the nature of color turns on rejecting both the metaphysical and epistemological constraints. I argue for this proposal as follows.

I motivate the claim that visual experiences have mental colors by way of empirical findings that show that neural properties of our visual systems explain our color categories, including the categories by which we classify colors as similar or dissimilar. I argue that these neural properties can be called colors by pointing out that the range of colors we perceive physical objects to have and the range of these neural properties are analogous ranges of properties. Relations among members of the range of these neural properties correspond with relations among members of the range of perceived colors.

However, subjectivism, which holds that the colors we attribute to physical objects in visual experience are mental colors, relies on either the metaphysical or the epistemological constraint. Hardin and McGilvray claim that no range of properties can be colors unless the members of the range of properties are intrinsically related in ways that correspond to the qualitative similarity relations that we're aware of in ordinary experience of color. Furthermore, this claim provides the basis of their argument that physical objects are colorless.

Boghossian and Velleman rely on a strong version of the epistemological constraint. They claim that because our ordinary experience of color provides access to the nature of color, and ordinary experience doesn't provide access to the physical natures of the properties of objects, the colors attributed to physical objects can't be physical properties.

Thus, due to their acceptance of either the metaphysical or the epistemological constraint, subjectivists hold that the colors we attribute to mind-independent objects in visual experience are mental colors. In an argument against projective representation of color in visual experience, I show that subjectivism cannot provide a plausible account of color perception.

This deep problem with explaining color perception provides a strong basis to reject subjectivism as well as

the strong version of the epistemological constraint on which Boghossian and Velleman's subjectivism is founded.

Thus, by way of this argument against projective representation of color, I argue that physical colors are needed to explain our perceptual experience of physical objects as colored. I conclude that there are two ranges of colors, mental colors and physical colors.

Due to acceptance of a weak version of the epistemological constraint on the nature of color, Johnston and Peacocke claim that physical colors are relations between physical properties of objects and visual experiences with mental colors. According to this weak version, our ordinary experience of color provides access to merely an aspect of the nature of color.

Both Johnston and Peacocke provide arguments for a weak version of the epistemological constraint. Johnston argues that considerations about skepticism support the claim that awareness of the qualitative similarity relations among colors in ordinary experience provides access to an aspect of the nature of color.

Peacocke argues that considerations brought out by the inverted spectrum thought experiment suggest that physical properties of objects are irrelevant in determining the colors we experience physical objects as having. Rather, properties of ordinary visual experience alone determine this, making plausible the claim that physical colors are

relations between physical properties of objects and color qualia, mental qualitative properties of visual experience which alone determine what it's like to experience physical objects as colored.

I show that neither Johnston's nor Peacocke's arguments are successful. In this case, we have no reason to accept Johnston's or Peacocke's dispositionalist proposals, or to accept the epistemological constraint on the nature of color.

Thompson argues that the colors of objects are relations between perceivers and objects, but his argument relies on the metaphysical constraint. He holds, as do Hardin and McGilvray, that for a range of properties to be identified with colors, members of the range of properties must be intrinsically related in ways that correspond to the qualitative similarity relations we're aware of in ordinary experience of color. Accepting that color categories are importantly determined by properties of our visual systems, but rejecting subjectivism, he concludes that the colors of objects are relations between properties of perceivers and objects.

However, if we draw a distinction between mental color and physical color, we can hold that color categories are explained by mental colors, independently of physical properties of objects. Thus, we have no reason to accept Thompson's relational view, or the metaphysical constraint

on the nature of color.

I conclude that although descriptions of colors according to our ordinary experience of color provide conceptual constraints on identifying a range of properties with colors, such descriptions don't specify the nature of color at all. Rather, descriptions of colors according to our ordinary experience merely serve to fix the reference of color terms.

Reference-fixing descriptions of causal relations among colored physical objects and mental states pick out monadic physical properties of physical objects as the referents of physical color terms. Such descriptions pick out monadic properties of neural processes as the referents of mental color terms.

Thus, physical colors are merely identified by way of visual experiences with mental colors. Physical colors aren't in part constituted by mental colors. In this case, the colors of physical objects are monadic physical properties, just as the shapes of physical objects are.

### Bibliography

- Anscombe, G. E. M. (1965). "The Intentionality of Sensation: A Grammatical Feature," in Analytical Philosophy, Second Series, ed. R. J. Butler. Oxford: Basil Blackwell, 158-180.
- Armstrong, D. M. (1968a). A Materialist Theory of the Mind. New York: Humanities Press.
- (1968b). "The Secondary Qualities: An Essay in the Classification of Theories," Australasian Journal of Philosophy, Vol. 46, No. 3 (December 1968): 225-241.
- (1969). "Colour Realism and the Argument from Microscopes" in Contemporary Philosophy in Australia, eds. Robert Brown and C. D. Rollins. London: George Allen & Unwin Ltd., 119-131. Reprinted in Armstrong, 1980, 104-118.
- (1976). "Immediate Perception," in Essays in Memory of Imre Lakatos, Boston Studies in the Philosophy of Science, Vol. 39, eds. R. S. Cohen, P. K. Feyerabend and W. M. Wartofsky. Dordrecht: D. Reidel Publishing Company, 23-35. Reprinted in Armstrong, 1980, 119-131.
- (1979). "Perception, Sense-data and Causality," in Perception and Identity: Essays Presented to A. J. Ayer with His Replies to Them, ed. G. F. Macdonald. London: Macmillan, 84-98. Reprinted in Armstrong, 1980, 132-148.
- (1980). The Nature of Mind. Ithaca, N. Y.: Cornell University Press.
- (1983). "Recent Work on the Relation of Mind and Brain," in Contemporary Philosophy: A New Survey, Vol. 4, ed. G. Floistad. The Hague: Martinus Nijhoff Publishers, 45-79.
- (1987). "Smart and the Secondary Qualities," in Metaphysics and Morality: Essays in Honour of J. J. C. Smart, eds. Philip Pettit, Richard Sylvan, and Jean Norman. Oxford: Basil Blackwell, 1-15.

- (1993). "Reply to Campbell," in Ontology, Causality and Mind: Essays in Honour of D. M. Armstrong, eds. John Bacon, Keith Campbell, and Lloyd Reinhardt. Cambridge: Cambridge University Press, 268-273.
- Armstrong, D. M. and Norman Malcolm (1984). Consciousness and Causality: A Debate on the Nature of Mind. Oxford: Basil Blackwell.
- Audi, Robert (1978). "The Ontological Status of Mental Images," Inquiry, Vol. 21, No. 3 (Autumn 1978): 348-361.
- Averill, Edward Wilson (1985). "Color and the Anthropocentric Problem," The Journal of Philosophy, Vol. 82, No. 6 (June 1985): 281-304.
- (1992). "The Relational Nature of Color," The Philosophical Review, Vol. 101, No. 3 (July 1992): 551-588.
- Baldwin, Thomas (1992). "The Projective Theory of Sensory Content," in The Contents of Experience: Essays on Perception, ed., Tim Crane. Cambridge: Cambridge University Press, 177-195.
- Bartleson, C. James (1976). "Brown," Color Research and Application, Vol. 1, No. 4 (Winter 1976): 181-191.
- Barth, F. G. (1985). Insects and Flowers: The Biology of a Partnership, trans. M. A. Biederman-Thorson. Princeton: Princeton University Press.
- Beck, Jacob (1975). "The Perception of Surface Color," Scientific American, Vol. 233, No. 2 (August 1975): 62-75.
- Bigelow, John, John Collins, and Robert Pargetter (1990). "Coloring in the World," Mind, Vol. 99, No. 394 (April 1990): 279-288.
- Biro, John (1996). "Dretske on Phenomenal Externalism," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 171-178.

- Block, Ned (1978). "Troubles with Functionalism," in Minnesota Studies in the Philosophy of Science, Vol. 9: Perception and Cognition, ed. C. Wade Savage. Minneapolis: University of Minnesota, 261-325. Reprinted in Rosenthal, 1991b, 211-228.
- (1980). "Are Absent Qualia Impossible?" The Philosophical Review, Vol. 89, No. 2 (April 1980): 257-274.
- (1990). "Inverted Earth," in Philosophical Perspectives, 4: Action Theory and Philosophy of Mind, ed. James E. Tomberlin. Atascadero, Cal.: Ridgeview Publishing Company, 53-79.
- (1996). "Mental Paint and Mental Latex," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 19-49.
- Block, Ned J. and Jerry A. Fodor (1972). "What Psychological States Are Not," The Philosophical Review, Vol. 81, No. 2 (April 1972): 159-181.
- Boff, Kenneth R., Lloyd Kaufman, and James P. Thomas (1986). Handbook of Perception and Human Performance, Vol. 1: Sensory Processes and Perception. New York: John Wiley and Sons.
- Boghossian, Paul A. and J. David Velleman (1989). "Colour as a Secondary Quality," Mind, Vol. 98, No. 389 (January 1989): 81-103.
- (1991). "Physicalist Theories of Color," The Philosophical Review, Vol. 100, No. 1 (January 1991): 67-106.
- Boynton, Robert M. (1979). Human Color Vision. New York: Holt, Rinehart and Winston.
- Broackes, Justin (1992). "The Autonomy of Colour," in Reduction, Explanation, and Realism, eds. David Charles and Kathleen Lennon. Oxford: Clarendon Press, 421-465.
- Brooks, D. M. H. (1992). "Secondary Qualities and Representation," Analysis, Vol. 52, No. 3 (July 1992): 174-179.

- Byrne, Alex and David R. Hilbert (forthcoming a).  
"Introduction," in Readings on Color, Vol. 1, The Philosophy of Color, eds. Alex Byrne and David R. Hilbert. Cambridge, Mass.: The MIT Press.
- (forthcoming b). "Colors and Reflectances," in Readings on Color, Vol. 1, The Philosophy of Color, eds. Alex Byrne and David R. Hilbert. Cambridge, Mass.: The MIT Press.
- Campbell, John (1993). "A Simple View of Color," in Reality, Representation and Perception, eds. John Haldane and Crispin Wright. Oxford: Oxford University Press, 257-268.
- (1996a). "Molyneux's Question," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 301-318.
- (1996b). "Shape Properties, Experience of Shape and Shape Concepts," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 351-363.
- Campbell, Keith (1969). "Colours," in Contemporary Philosophy in Australia, eds. Robert Brown and C. D. Rollins. London: George Allen & Unwin Ltd., 132-157.
- (1982). "The Implications of Land's Theory of Color Vision," in Logic, Methodology and Philosophy of Science, 6, ed. L. J. Cohen. Amsterdam: North-Holland Publishing Co., 541-552. Reprinted in Lycan, 1990a, 567-576.
- (1993). "David Armstrong and Realism about Colour," in Ontology, Causality and Mind: Essays in Honour of D. M. Armstrong, eds. John Bacon, Keith Campbell, and Lloyd Reinhardt. Cambridge: Cambridge University Press, 249-268.
- Chappell, V. C., ed. (1981). The Philosophy of Mind. New York: Dover Publications, Inc.
- Chisholm, Roderick M. (1957). Perceiving: A Philosophical Study. Ithaca, N. Y.: Cornell University Press.

- (1966). "The Status of Appearances," in his Theory of Knowledge. Englewood Cliffs, N. J.: Prentice-Hall, 91-98. Reprinted in Rosenthal, 1991b, 380-384. Page numbers refer to reprint.
- Churchland, Paul M. (1985). "Reduction, Qualia, and the Direct Introspection of Brain States," The Journal of Philosophy, Vol. 82, No. 1 (January 1985): 8-28.
- Clark, Austen (1985a). "Qualia and the Psychophysiological Explanation of Color Perception," Synthese, Vol. 65 No. 3 (December 1985): 377-405.
- (1985b). "A Physicalist Theory of Qualia," The Monist, Vol. 68, No. 4 (October 1985): 491-506.
- (1985c). "Spectrum Inversion and the Color Solid," The Southern Journal of Philosophy, Vol. 23, No. 4 (Winter 1985): 431-443.
- (1989). "The Particulate Instantiation of Homogeneous Pink," Synthese, Vol. 80, No. 2 (August 1989): 277-304
- (1993). Sensory Qualities. Oxford: Clarendon Press.
- (1996a). "Commentary: True Theories, False Colors," in Proceedings of the 1996 Biennial Meeting of the Philosophy of Science Association, Part I, Contributed Papers, ed. Lindley Darden, S143-S150.
- (1996b). "Three Varieties of Visual Field," Philosophical Psychology, Vol. 9, No. 4 (December 1996): 477-495.
- Coady, C. A. J. (1974). "The Senses of Martians," The Philosophical Review, Vol. 83, No. 1 (January 1974): 107-125.
- Conee, Earl (1985). "Physicalism and Phenomenal Qualities," The Philosophical Quarterly, Vol. 35, No. 140 (July 1985): 296-302.
- (1994). "Phenomenal Knowledge," Australasian Journal of Philosophy, Vol. 72, No. 2 (June 1994): 136-150.
- Cornsweet, Tom N. (1970). Visual Perception. New York: Academic Press.

- Crane, Hewitt. D. and Thomas P. Piantanida (1983). "On Seeing Reddish Green and Yellowish Blue," Science, Vol. 221, No. 4615 (September 9, 1983): 1078-1080.
- Crane, Tim, ed. (1992a). The Contents of Experience: Essays on Perception. Cambridge: Cambridge University Press.
- Crane, Tim (1992b). "Introduction," in The Contents of Experience: Essays on Perception, ed. Tim Crane. Cambridge: Cambridge University Press, 1-17.
- (1992c). "The Nonconceptual Content of Experience," in The Contents of Experience: Essays on Perception, ed. Tim Crane. Cambridge: Cambridge University Press, 136-157.
- Dannemiller, James L. (1992). "Color is as Color Does," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 33-34.
- Dedrick, Don (1995). "Objectivism and the Evolutionary Value of Colour Vision," Dialogue, Vol. 34, No. 1 (Winter 1995): 35-44.
- (1996). "Can Colour Be Reduced to Anything?" in Proceedings of the 1996 Biennial Meeting of the Philosophy of Science Association, Part I, Contributed Papers, ed. Lindley Darden, S134-S142.
- Dennett, Daniel C. (1988). "Quining Qualia," in Consciousness in Contemporary Science, eds. A. J. Marcel and E. Bisiach. New York: Oxford University Press, 42-77. Reprinted in Lycan, 1990a, 519-547.
- (1991a). Consciousness Explained. Boston: Little, Brown and Company.
- (1991b). "Lovely and Suspect Qualities," in Philosophical Issues, 1: Consciousness, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 37-44.
- (1993). "The Message Is: There Is No Medium," Philosophy and Phenomenological Research, Vol. 53, No. 4 (December 1993): 919-931.
- Dretske, Fred I. (1979). "Simple Seeing," in Body, Mind and Method: Essays in Honor of Virgil C. Aldrich, eds. Donald F. Gustafson and Bangs L. Tapscott. Dordrecht: D. Reidel Publishing Company, 1-15.

- (1980). "The Intentionality of Cognitive States," in Midwest Studies in Philosophy, Vol. 5: Studies in Epistemology, eds. Peter A. French, Theodore E. Uehling, Jr., and Howard K. Wettstein. Minneapolis: University of Minnesota Press, 281-294.
- (1995). Naturalizing the Mind. Cambridge, Mass.: The MIT Press.
- (1996a). "Phenomenal Externalism or If Meanings Ain't in the Head, Where Are Qualia?" in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 143-158.
- (1996b). "Reply to Commentators," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 179-183.
- Evans, Gareth (1980). "Things Without the Mind--A Commentary upon Chapter Two of Strawson's Individuals," in Philosophical Subjects: Essays Presented to P. F. Strawson. Oxford: Clarendon Press, 76-116.
- (1985). "Molyneux's Question," in his Collected Papers. Oxford: Clarendon Press, 364-399.
- Feldman, Jerome A. (1992). "Enactivist Vision," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 35-36.
- Finkelstein, Marcia A. (1992). "Psychophysical Modeling: The Link between Objectivism and Subjectivism," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 36-37.
- Gibbard, Allan (1996). "Visible Properties of Human Interest Only," Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 199-208.
- Gouras, Peter (1985). "Color Vision," in Principles of Neural Science, Second Edition, eds. E. R. Kandel and J. H. Schwartz. New York: Elsevier Science Publishing Co., 384-395.

- Grandy, Richard E. (1989). "A Modern Inquiry into the Physical Reality of Colors," in Mind, Value, and Culture: Essays in Honor of E. M. Adams, ed. David Weissbord. Atascadero, Cal.: Ridgeview Publishing Company, 229-245.
- Grice, Paul (1961). "The Causal Theory of Perception," Proceedings of the Aristotelian Society, Supplementary Vol. 35 (1961): 121-152. Reprinted in Grice, 1989, 224-247.
- (1962). "Some Remarks about the Senses," in Analytical Philosophy, First Series, ed. R. J. Butler. Oxford: Basil Blackwell, 133-153. Reprinted in Grice, 1989, 248-268.
- (1989). Studies in the Ways of Words. Cambridge, Mass.: Harvard University Press.
- Hall, Richard J. (1996). "The Evolution of Color Vision without Colors," in Proceedings of the 1996 Biennial Meeting of the Philosophy of Science Association, Part I, Contributed Papers, ed. Lindley Darden, S125-S133.
- Hardin, C. L. (1983). "Colors, Normal Observers and Standard Conditions," The Journal of Philosophy, Vol. 80, No. 12 (December 1983): 806-813.
- (1984a). "A New Look at Color," American Philosophical Quarterly, Vol. 21, No. 2 (April 1984): 125-133.
- (1984b). "Are 'Scientific' Objects Coloured?" Mind, Vol. 93, No. 372 (October 1984): 491-500.
- (1985). "The Resemblances of Colors," Philosophical Studies, Vol. 48, No. 1 (July 1985): 35-47.
- (1988). "Phenomenal Colors and Sorites," Nous, Vol. 22, No. 2 (June 1988): 213-234.
- (1989). "Could White Be Green?" Mind, Vol. 98, No. 390 (April 1989): 285-288.
- (1990). "Color and Illusion," in Mind and Cognition: A Reader, ed. William G. Lycan. Oxford: Basil Blackwell, 555-567.

- (1991a). "Color for Philosophers: A Precis," Philosophical Psychology, Vol. 4, No. 1 (1991): 21-26.
- (1991b). "Reply to Levine," Philosophical Psychology, Vol. 4, No. 1 (1991): 41-50.
- (1991c). "Reply to Teller," Philosophical Psychology, Vol. 4, No. 1 (1991): 61-64.
- (1992). "The Virtues of Illusion," Philosophical Studies, Vol. 68, No. 3 (December 1992): 371-382.
- (1993a). Color for Philosophers: Unweaving the Rainbow, Expanded Edition. Indianapolis: Hackett Publishing Company.
- (1993b). "Van Brakel and the Not-So-Naked Emperor," British Journal for the Philosophy of Science, Vol. 44, No. 1 (March 1993): 137-150.
- (forthcoming). "Reinverting the Spectrum," in Readings on Color, Vol. 1, The Philosophy of Color, eds. Alex Byrne and David R. Hilbert. Cambridge, Mass.: The MIT Press.
- Harding, Gregory (1991). "Color and the Mind-Body Problem," Review of Metaphysics, Vol. 45, No. 2 (December 1991): 289-307.
- Harman, Gilbert (1990). "The Intrinsic Quality of Experience," in Philosophical Perspectives, 4: Action Theory and Philosophy of Mind, ed. James E. Tomberlin. Atascadero, Cal.: Ridgeview Publishing Company, 31-52.
- (1996a). "Explaining Objective Color in Terms of Subjective Reactions," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 1-17.
- (1996b). "Qualia and Color Concepts," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 75-79.

- Hatfield, Gary (1992). "Color Perception and Neural Encoding: Does Metameric Matching Entail a Loss of Information?" in Proceedings of the 1992 Biennial Meeting of the Philosophy of Science Association, Vol. 1, Contributed Papers, eds. David Hull, Micky Forbes, and Kathleen Okruhlik, 492-504.
- Hilbert, David R. (1987). Color and Color Perception: A Study in Anthropocentric Realism. Stanford: Center for the Study of Language and Information.
- (1992). "What Is Color Vision?" Philosophical Studies, Vol. 68, No. 3 (December 1992): 351-370.
- Holborow, L. C. (1969). "Against Projecting Pains," Analysis, Vol. 29, No. 3 (January 1969): 105-108.
- Holton, Richard (1992). "Response-Dependence and Infallibility," Analysis, Vol. 52, No. 3 (July 1992): 180-184.
- Horgan, Terence (1984a). "Jackson on Physical Information and Qualia," The Philosophical Quarterly, Vol. 34, No. 135 (April 1984): 147-152.
- (1984b). "Functionalism, Qualia, and the Inverted Spectrum," Philosophy and Phenomenological Research, Vol. 44, No. 4. (June 1984): 453-469.
- (1987). "Supervenient Qualia," The Philosophical Review, Vol. 96, No. 4 (October 1987): 491-520.
- Horwich, Paul (1996). "Comment on Dretske," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 167-170.
- Hurlbert, Anya (1992). "The View of a Computational Animal," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 39-40.
- Hurvich, Leo M. (1981). Color Vision. Sunderland, Mass.: Sinauer Associates Inc.
- Jackson, Frank (1976). "The Existence of Mental Objects," American Philosophical Quarterly, Vol. 13, No. 1 (January 1976): 33-40. Reprinted in Rosenthal, 1991b, 385-391.

- (1977). Perception: A Representative Theory.  
Cambridge: Cambridge University Press.
- (1982). "Epiphenomenal Qualia," The  
Philosophical Quarterly, Vol. 32, No. 127 (April  
1982): 127-136. Reprinted in Lycan, 1990a, 469-477.
- (1986). "What Mary Didn't Know," The Journal of  
Philosophy, Vol. 83, No. 5 (May 1986): 291-295.  
Reprinted in Rosenthal, 1991b, 392-394.
- (1993). "Block's Challenge," in Ontology,  
Causality and Mind: Essays in Honour of D. M.  
Armstrong, eds. John Bacon, Keith Campbell, and Lloyd  
Reinhardt. Cambridge: Cambridge University Press,  
235-248.
- Jackson, Frank and Robert Pargetter (1987). "An  
Objectivist's Guide to Subjectivism about Colour,"  
Revue Internationale de Philosophie, Vol. 41, No. 160  
(fascicule 1/1987): 127-141.
- Jacobs, Gerald H. (1981). Comparative Color Vision. New  
York: Academic Press.
- (1992). "Data and Interpretation in Comparative  
Color Vision," Behavioral and Brain Sciences, Vol.  
15, No. 1 (March 1992): 40-41.
- Johnston, Mark (1989). "Dispositional Theories of Value,"  
Proceedings of the Aristotelian Society,  
Supplementary Vol. 63 (1989): 139-174.
- (1992). "How to Speak of the Colors,"  
Philosophical Studies, Vol. 68, No. 3 (December  
1992): 221-263.
- (1993). "Objectivity Refigured: Pragmatism  
Without Verificationism," in Reality, Representation  
and Perception, eds. John Haldane and Crispin Wright.  
Oxford: Oxford University Press, 85-130.
- (1996a). "Is the External World Invisible?" in  
Philosophical Issues, 7: Perception, ed. Enrique  
Villanueva. Atascadero, Cal.: Ridgeview Publishing  
Company, 185-198.
- (1996b). "A Mind-Body Problem at the Surface of  
Objects," in Philosophical Issues, 7: Perception,  
ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview  
Publishing Company, 219-229.

- (unpublished manuscript a). "The Obscure Object of Hallucination."
- (unpublished manuscript b). "Impressionism, Primitivism and Relativity."
- Kobes, Bernard W. (1991). "Sensory Qualities and 'Homunctionalism': A Review Essay of W. G. Lycan's Consciousness," Philosophical Psychology, Vol. 4, No. 1 (1991): 147-158.
- Kim, Jaegwon (1996). "Dretske's Qualia Externalism," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 159-165.
- Kitcher, Patricia (1979). "Phenomenal Qualities," American Philosophical Quarterly, Vol. 16, No. 2 (April 1979): 123-129.
- Kraut, Robert (1982). "Sensory States and Sensory Objects," Nous, Vol. 16, No. 2 (May 1982): 277-293.
- (1992). "The Objectivity of Color and the Color of Objectivity," Philosophical Studies, Vol. 68, No. 3 (December 1992): 265-287.
- Kripke, Saul A. (1972). Naming and Necessity. Cambridge, Mass.: Harvard University Press.
- Land, Edwin H. (1977). "The Retinex Theory of Color Vision," Scientific American, Vol. 237, No. 6 (December 1977): 108-128.
- (1983). "Recent Advances in Retinex Theory and Some Implications for Cortical Computations: Color Vision and the Natural Image," Proceedings of the National Academy of Sciences, Vol. 80, No. 16 (August 1983): 5163-5169.
- Landesman, Charles (1989). Color and Consciousness: An Essay in Metaphysics. Philadelphia: Temple University Press.
- (1993a). The Eye and the Mind: Reflections on Perception and the Problem of Knowledge. Dordrecht: Kluwer Academic Publishers.

- (1993b). "Why Nothing Has Color: Color Skepticism," in Theory of Knowledge: Classical and Contemporary Readings, ed., Louis P. Pojman. Belmont, Cal.: Wadsworth Publishing Company, 121-126.
- Lahav, Ran (1990). "An Alternative to the Adverbial Theory: Dis-Phenomenalism," Philosophy and Phenomenological Research, Vol. 50, No. 3 (March 1990): 553-568.
- Leeds, Stephen (1975). "Two Senses of 'Appears Red'," Philosophical Studies, Vol. 28, No. 3 (September 1975): 199-205.
- Levin, Janet (1986). "Could Love Be Like a Heatwave? Physicalism and the Subjective Character of Experience," Philosophical Studies, Vol. 49, No. 2 (March 1986): 245-261. Reprinted in Lycan, 1990a, 478-490.
- (1987). "Physicalism and the Subjectivity of Secondary Qualities," Australasian Journal of Philosophy, Vol. 65, No. 4 (December 1987): 400-411.
- Levine, Joseph (1983). "Materialism and Qualia: The Explanatory Gap," Pacific Philosophical Quarterly, Vol. 64, No. 4 (October 1983): 354-361.
- (1991). "Cool Red," Philosophical Psychology, Vol. 4, No. 1 (1991): 27-40.
- (1992). "Objectivism-Subjectivism: A False Dilemma?" Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 42-43.
- (1993). "On Leaving Out What It's Like," in Consciousness: Psychological and Philosophical Essays, eds. Martin Davies and Glyn W. Humphreys. Oxford: Basil Blackwell, 121-136.
- Lewis, David (1972). "Psychophysical and Theoretical Identifications," Australasian Journal of Philosophy, Vol. 50, No. 3 (December 1972): 249-258. Reprinted in Rosenthal, 1991b, 204-210.
- (1980a). "Mad Pain and Martian Pain," in Readings in the Philosophy of Psychology, Vol. 1, ed. Ned Block. Cambridge, Mass.: Harvard University Press, 216-222. Reprinted in Rosenthal, 1991b, 229-234. Page numbers refer to reprint.

- (1980b). "Veridical Hallucination and Prosthetic Vision," Australasian Journal of Philosophy, Vol. 58, No. 3 (September 1980): 239-249.
- (1983). "Postscript to 'Mad Pain and Martian Pain'," in his Philosophical Papers, Vol. 1. New York: Oxford University Press, 130-132. Reprinted in Rosenthal, 1991b, 234-235. Page numbers refer to reprint.
- (1988). "What Experience Teaches," Proceedings of the Russellian Society, University of Sydney. Reprinted in Lycan, 1990a, 499-519. Page numbers refer to reprint.
- (1995). "Should a Materialist Believe in Qualia?" Australasian Journal of Philosophy, Vol. 73, No. 1 (March 1995): 140-144.
- (forthcoming). "Naming the Colours," Australasian Journal of Philosophy.
- Loar, Brian (1990). "Phenomenal States," in Philosophical Perspectives, 4: Action Theory and Philosophy of Mind, ed. James E. Tomberlin. Atascadero, Cal.: Ridgeview Publishing Company, 81-108.
- (1996). "Comments on John Campbell's 'Molyneux's Question'," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 319-324.
- Locke, John (1975). An Essay Concerning Human Understanding, ed. Peter H. Nidditch. Oxford: Clarendon Press.
- Ludwig, Kirk (1996). "Shape Properties and Perception," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 325-350.
- Lycan, William G. (1987). Consciousness. Cambridge, Mass.: The MIT Press.
- ed. (1990a). Mind and Cognition: A Reader. Oxford: Basil Blackwell.

- (1990b). "What is the 'Subjectivity' of the Mental?" in Philosophical Perspectives, 4: Action Theory and Philosophy of Mind, ed. James E. Tomberlin. Atascadero, Cal.: Ridgeview Publishing Company, 109-130.
- (1996). Consciousness and Experience. Cambridge, Mass.: The MIT Press.
- Lythgoe, J. N. (1979). The Ecology of Vision. Oxford: Oxford University Press.
- MacIntyre, Alasdair (1992). "Colors, Culture, and Practices," Midwest Studies in Philosophy, Vol. 17: The Wittgenstein Legacy, eds. Peter A. French, Theodore E. Uehling, Jr., and Howard K. Wettstein. Notre Dame, Ind.: University of Notre Dame Press, 1-23.
- Maier, Ehard and Dietrich Burkhardt (1992). "In Search of Common Features of Animals' Color Vision Systems and the Constraints of Environment," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 44-45.
- Maloney, Laurence T. (1986). "Evaluation of Linear Models of Surface Spectral Reflectance with Small Numbers of Parameters," Journal of the Optical Society of America, A, Vol. 3, No. 10 (October 1986): 1673-1683.
- Maloney, Laurence T. and Brian A. Wandell (1986). "Color Constancy: A Method for Recovering Surface Spectral Reflectance," Journal of the Optical Society of America, A, Vol. 3, No. 1 (January 1986): 29-33.
- Martin, Michael (1992). "Sight and Touch," in The Contents of Experience: Essays on Perception, ed. Tim Crane. Cambridge: Cambridge University Press, 196-215.
- Matthen, Mohan (1988). "Biological Functions and Perceptual Content," The Journal of Philosophy, Vol. 85, No. 1 (January 1988): 5-27.
- (1989). "Intensionality and Perception: A Reply to Rosenberg," The Journal of Philosophy, Vol. 86, No. 12 (December 1989): 727-733.
- (1992). "Color Vision: Content Versus Experience," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 46-47.

- Maund, J. B. (1981). "Colour--A Case for Conceptual Fission," Australasian Journal of Philosophy, Vol. 59, No. 3 (September 1981): 308-322.
- (1995). Colours: Their Nature and Representation. Cambridge: Cambridge University Press.
- Mausfeld, Rainer, Reinhard M. Niederee, and K. Dieter Heyer (1992). "On Possible Perceptual Worlds and How They Shape Their Environments," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 47-48.
- McDowell, John (1985). "Values and Secondary Qualities," in Morality and Objectivity: A Tribute to J. L. Mackie, ed. Ted Honderich. London: Routledge & Kegan Paul, 110-129.
- McFarland, W. N. and F. W. Munz (1975). "The Evolution of Photopic Visual Pigments in Fishes," Vision Research, Vol. 15, No. 10 (October 1975): 1071-1080.
- McGilvray, James A. (1983). "To Color," Synthese, Vol. 54, No. 1 (January 1983): 37-70.
- (1991). Review of C. L. Hardin's Color for Philosophers, in Philosophy of Science, Vol. 58, No. 2 (June 1991): 329-331.
- (1992). "Colors Really Are Only in the Head," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 48-49.
- (1994). "Constant Colors in the Head," Synthese, Vol. 100, No. 2 (August 1994): 197-239.
- McGinn, Colin (1983). The Subjective View: Secondary Qualities and Indexical Thoughts. Oxford: Clarendon Press.
- (1996). "Another Look at Color," The Journal of Philosophy, Vol. 93, No. 11 (November 1996): 537-553.
- McGinn, Marie (1991). "On Two Recent Accounts of Colour," The Philosophical Quarterly, Vol. 41, No. 164 (July 1991): 316-324.

- Menzel, Randolph (1979). "Spectral Sensitivity and Colour Vision in Invertebrates," in Comparative Physiology and Evolution of Vision in Invertebrates. Handbook of Sensory Physiology, Vol. VII/6A, ed. H. Autrum. Berlin: Springer-Verlag, 503-580.
- Menzies, Peter and Philip Pettit (1993). "Found: The Missing Explanation," Analysis, Vol. 53, No. 2 (April 1993): 100-109.
- Mollon, J. D. (1989). "'Tho' She Kneel'd in That Place Where They Grew . . ." The Uses and Origins of Primate Colour Vision," Journal of Experimental Biology, Vol. 146 (September 1989): 21-38.
- Nagel, Thomas (1974). "What Is It Like to Be a Bat?" The Philosophical Review, Vol. 83, No. 4 (October 1974): 435-450. Reprinted in Rosenthal, 1991b, 422-428.
- Nassau, Kurt (1980). "The Causes of Color," Scientific American, Vol. 243, No. 10 (October 1980): 124-154.
- Nelkin, Norton (1994). "Phenomena and Representation," British Journal for the Philosophy of Science, Vol. 45, No. 2 (June 1994): 527-547.
- Nemirow, Laurence (1990). "Physicalism and the Cognitive Role of Acquaintance," in Mind and Cognition: A Reader, ed. William G. Lycan. Oxford: Basil Blackwell, 490-499.
- Neumeier, C. (1980). "Simultaneous Color Contrast in the Honeybee," Journal of Comparative Physiology, A, Vol. 139, No. 3 (1980): 165-176.
- (1981). "Chromatic Adaptation in the Honeybee: Successive Color Contrast and Color Constancy," Journal of Comparative Physiology, A, Vol. 144, No. 4 (1981): 543-553.
- Nida-Rumelin, Martine (1996). "Pseudonormal Vision: An Actual Case of Qualia Inversion?" Philosophical Studies, Vol. 82, No. 2 (May 1996): 145-157.
- Nuboer, J. F. W. (1986). "A Comparative View on Colour Vision," Netherlands Journal of Zoology, Vol. 36, No. 3 (1986): 344-380.
- Peacocke, Christopher (1983). Sense and Content, Oxford: Clarendon Press.

- (1984a). "Color Concepts and Color Experiences," Synthese, Vol. 58, No. 3 (March 1984): 365-381. Reprinted in Rosenthal, 1991b, 408-416. Page numbers refer to reprint.
- (1984b). "Consciousness and Other Minds," Proceedings of the Aristotelian Society, Supplementary Vol. 58 (1984): 97-117.
- (1986). "Reply to Michael Smith," Synthese, Vol. 68, No. 3 (September 1986): 577-580.
- (1989a). "Perceptual Content," in Themes from Kaplan, eds. Joseph Almog, John Perry and Howard Wettstein. New York: Oxford University Press, 297-329.
- (1989b). "Possession Conditions: A Focal Point for Theories of Concepts," Mind and Language, Vol. 4, Nos 1 and 2 (Spring/Summer 1989): 197-202.
- (1992a). "Scenarios, Concepts and Perception," in The Contents of Experience: Essays on Perception, ed. Tim Crane. Cambridge: Cambridge University Press, 105-135.
- (1992b). A Study of Concepts. Cambridge, Mass.: The MIT Press.
- (1996). "Precis of A Study of Concepts," Philosophy and Phenomenological Research, Vol. 56, No. 2 (June 1996): 407-411
- Pereboom, Derk (1994). "Bat, Brain Scientists, and the Limitations of Introspection," Philosophy and Phenomenological Research, Vol. 54, No. 2 (June 1994): 315-329.
- Pettit, Philip (1991). "Realism and Response-Dependence," Mind. Vol. 100, No. 4 (October 1991): 587-626.
- Pitcher, George (1969). "Minds and Ideas in Berkeley," American Philosophical Quarterly, Vol. 6, No. 3 (July 1969): 198-207.
- (1970). "Pain Perception," Philosophical Review, Vol. 79, No. 3 (July 1970): 368-393.
- (1971). A Theory of Perception. Princeton, N. J.: Princeton University Press.

- Place, U. T. (1956). "Is Consciousness a Brain Process?" British Journal of Psychology, Vol. 47, Part 1 (February 1956): 44-50. Reprinted in Chappell, 1981, 101-109.
- Pokorny, Joel and Vivianne C. Smith (1986). "Colorimetry and Color Discrimination," in Handbook of Perception and Human Performance, Vol. 1: Sensory Processes and Perception, eds. Kenneth R. Boff, Lloyd Kaufman, and James P. Thomas. New York: John Wiley and Sons, Chapter 8.
- Radner, Daisie (1994). "Heterophenomenology: Learning about the Birds and the Bees," The Journal of Philosophy, Vol. 91, No. 8 (August 1994): 389-403.
- Reeves, Adam (1992). "Areas of Ignorance and Confusion in Color Science," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 49-50.
- Robinson, Denis (1993). "Epiphenomenalism, Laws and Properties," Philosophical Studies, Vol. 69, No. 1 (January 1993): 1-34.
- Rock, Irvin (1975). An Introduction to Perception. New York: Macmillan Publishing Co., Inc.
- Rosenthal, David M. (1983). "Reductionism and Knowledge," in How Many Questions?, eds. L. Cauman, I. Levi, C. Parsons and R. Schwartz. Indianapolis: Hackett Publishing Company, 276-300.
- (1984). "Armstrong's Causal Theory of Mind," in Profiles: D. M. Armstrong, ed. R. J. Bogdan. Dordrecht: D. Reidel Publishing Co., 79-120.
- (1985). Review of Frank Jackson's Perception: A Representative Theory, in The Journal of Philosophy, Vol. 82, No. 1 (January 1985): 28-41.
- (1991a). "The Independence of Consciousness and Sensory Quality," in Philosophical Issues, 1: Consciousness, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 15-36.
- ed. (1991b). The Nature of Mind. Oxford: Oxford University Press.
- (1993). "Multiple Drafts and Higher-Order Thoughts," Philosophy and Phenomenological Research, Vol. 53, No. 4 (December 1993): 911-918.

- (forthcoming). "The Colors and Shapes of Visual Experiences," in Consciousness and Intentionality, eds. Denis Fisette and Pierre Livet.
- Ross, Peter W. (forthcoming). "Trichromacy and the Neural Basis of Color Discrimination," Commentary on B. A. C. Saunders and J. van Brakel, "Are There Nontrivial Constraints on Colour Categorization?" Behavioral and Brain Sciences.
- Roxbee Cox, J. W. (1970). "Distinguishing the Senses," Mind, Vol. 79, No. 316 (October 1970): 530-550.
- Russell, Bertrand. (1912). The Problems of Philosophy. London: Oxford University Press.
- Sanford, David H. (1981). "Illusions and Sense-Data," in Midwest Studies in Philosophy, Vol. 6: Foundations of Analytic Philosophy, eds. Peter A. French, Theodore E. Uehling, Jr. and Howard K. Wettstein. Minneapolis: University of Minnesota Press, 371-385.
- (1983). "The Perception of Shape," in Knowledge and Mind: Philosophical Essays, eds. Carl Ginet and Sydney Shoemaker. New York: Oxford University Press, 130-158.
- (1984). "Armstrong's Theory of Perception," in Profiles: D. M. Armstrong, ed. R. J. Bogdan. Dordrecht: D. Reidel Publishing Co., 55-78.
- Saunders, B. A. C. and J. van Brakel (forthcoming). "Are There Nontrivial Constraints on Colour Categorization?" Behavioral and Brain Sciences.
- Sellars, Wilfrid (1956). "Empiricism and the Philosophy of Mind," in Minnesota Studies in the Philosophy of Science, Vol. 1, eds. Herbert Feigl and Michael Scriven. Minneapolis: University of Minnesota Press, 253-329.
- (1963a). "Phenomenalism," in his Science, Perception and Reality, London: Routledge & Kegan Paul, 91-95. Reprinted in Rosenthal, 1991b, 417-419. Page numbers refer to reprint.
- (1963b). "Philosophy and the Scientific Image of Man," in his Science, Perception and Reality, London: Routledge & Kegan Paul, 1-40.

- Shepard, Roger N. (1992). "The Perceptual Organization of Colors: An Adaptation to Regularities of the Terrestrial World?" in The Adapted Mind: Evolutionary Psychology and the Generation of Culture, eds. Jerome H. Barkow, Leda Cosmides, and John Tooby. New York: Oxford University Press, 495-532.
- (1993). "On the Physical Basis, Linguistic Representation, and Conscious Experience of Colors," in Conceptions of the Human Mind: Essays in Honor of George A. Miller, ed. Gilbert Harman. Hillsdale, N. J.: Lawrence Erlbaum Associates, Publishers, 217-245.
- Shoemaker, Sydney (1975a). "Functionalism and Qualia," Philosophical Studies, Vol. 27, No. 5 (May 1975): 292-315. Reprinted in Rosenthal, 1991b, 395-407.
- (1975b). "Phenomenal Similarity," Critica: Revista Hispanoamericana de Filosofia, Vol. 7, No. 20 (October 1975): 3-37.
- (1981). "Absent Qualia Are Impossible--A Reply to Block," The Philosophical Review, Vol. 90, No. 4 (October 1981): 581-599.
- (1982). "The Inverted Spectrum," Journal of Philosophy, Vol. 79, No. 7 (July 1982): 357-381.
- (1990). "Qualities and Qualia: What's in the Mind?" Philosophy and Phenomenological Research, Vol. 50, Supplement (Fall 1990): 109-131.
- (1991). "Qualia and Consciousness," Mind, Vol. 100, No. 4 (October 1991): 507-524.
- (1993). "Lovely and Suspect Ideas," Philosophy and Phenomenological Research, Vol. 53, No. 4 (December 1993): 905-910.
- (1994a). "Phenomenal Character," Nous, Vol. 28, No. 1 (March 1994): 21-38.
- (1994b). "Self-Knowledge and 'Inner Sense'," Philosophy and Phenomenological Research, Vol. 54, No. 2 (June 1994): 249-314.

- (1996). "Colors, Subjective Relations and Qualia," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 55-66.
- Smart, J. J. C. (1959). "Sensations and Brain Processes," The Philosophical Review, Vol. 68, No. 2 (April 1959): 141-156. Reprinted in Chappell, 1981, 160-172.
- (1975). "On Some Criticisms of a Physicalist Theory of Colors," in Philosophical Aspects of the Mind-Body Problem, ed. Chung-ying Cheng. Honolulu: University of Hawaii Press, 54-63.
- (1987). "Reply to Armstrong," in Metaphysics and Morality: Essays in Honor of J. J. C. Smart, eds. Philip Pettit, Richard Sylvan and Jean Norman. Oxford: Basil Blackwell, 174-176.
- (1995). "'Looks Red' and Dangerous Talk," Philosophy, Vol. 70, No. 274 (October 1995): 545-554.
- Smith, Michael A. (1986). "Peacocke on Red and Red'," Synthese, Vol. 68, No. 3 (September 1986): 559-576.
- (1993). "Colour, Transparency, Mind-Independence," in Reality, Representation and Perception, eds. John Haldane and Crispin Wright. Oxford: Oxford University Press, 269-277.
- Sosa, David (1996). "Getting Acquainted with Perception," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 209-214.
- Sosa, Ernest (1996). "Is Color Psychological or Biological? Or Both?" in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 67-74.
- Strawson, Galen (1989). "'Red' and Red," Synthese, Vol. 78, No. 2 (February 1989): 193-232.
- Stroud-Drinkwater, Clive (1994). "The Naive Theory of Colour," Philosophy and Phenomenological Research, Vol. 54, No. 2 (June 1994): 345-354.

- Sturgeon, Scott. (1994). "The Epistemic View of Subjectivity," The Journal of Philosophy, Vol. 91, No. 5 (May 1994): 221-235.
- Teller, Davida Y. (1990). "The Domain of Visual Science," in Visual Perception: The Neurophysiological Foundations, eds. Lothar Spillman and John S. Werner. San Diego: Academic Press, Inc., 11-21.
- (1991). "Simpler Arguments Might Work Better," Philosophical Psychology, Vol. 4, No. 1 (1991): 51-60.
- Thompson, Evan (1992). "Novel Colours," Philosophical Studies, Vol. 68, No. 3 (December 1992): 321-349.
- (1995a). Colour Vision: A Study in Cognitive Science and the Philosophy of Perception. London: Routledge.
- (1995b). "Colour Vision, Evolution, and Perceptual Content," Synthese, Vol. 104, No. 1 (July 1995): 1-32.
- Thompson, Evan, Adrian Palacios, and Francisco J. Varela (1992). "Ways of Coloring: Comparative Color Vision as a Case Study for Cognitive Science," Behavioral and Brain Sciences, Vol. 15, No. 1 (March 1992): 1-26.
- Thomson, Judith Jarvis (1974). "Molyneux's Problem," The Journal of Philosophy, Vol. 71, No. 18 (October 24, 1974): 637-650.
- Tye, Michael (1986). "The Subjective Qualities of Experience," Mind, Vol. 95, No. 377 (January 1986): 1-17.
- (1989). The Metaphysics of Mind. Cambridge: Cambridge University Press.
- (1992). "Visual Qualia and Visual Content," in The Contents of Experience: Essays on Perception, ed. Tim Crane. Cambridge: Cambridge University Press, 158-176.
- (1993a). "Blindsight, the Absent Qualia Hypothesis, and the Mystery of Consciousness," in Philosophy and the Cognitive Sciences, Supplement to Philosophy, ed. Christopher Hookway. Cambridge: Cambridge University Press, 19-40.

- (1993b). "Reflections on Dennett and Consciousness," Philosophy and Phenomenological Research, Vol. 53, No. 4 (December 1993): 893-898.
- (1994). "Qualia, Content, and the Inverted Spectrum," Nous, Vol. 28, No. 2 (June 1994): 159-183.
- (1995a). Ten Problems of Consciousness: A Representational Theory of the Phenomenal Mind. Cambridge, Mass.: The MIT Press.
- (1995b). "What What It's Like Is Really Like," Analysis, Vol. 55, No. 2 (April 1995): 125-126.
- (1996). "Orgasms Again," in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 51-54.
- van Brakel, J. (1993). "The Plasticity of Categories: The Case of Color," British Journal for the Philosophy of Science, Vol. 44, No. 1 (March 1993): 103-135.
- van der Glas, H. W. (1980). "Orientation of Bees, Apis Mellifera, to Unpolarized Colour Patterns, Simulating the Polarized Skylight Pattern," Journal of Comparative Physiology, A, Vol. 139, No. 3 (1980): 225-241.
- Varela, Francisco, J., Adrian Palacios, and T. H. Goldsmith (1993). "Color Vision of Birds," in Vision, Brain, and Behavior of Birds, eds. H. P. Zeigler and H. J. Bischof. Cambridge, Mass.: The MIT Press.
- Vendler, Zeno (1995). "Goethe, Wittgenstein, and the Essence of Color," The Monist, Vol. 78, No. 4 (October 1995): 391-410.
- Villanueva, Enrique (1996). "Would More Acquaintance with the External World Relieve Epistemic Anxiety?" in Philosophical Issues, 7: Perception, ed. Enrique Villanueva. Atascadero, Cal.: Ridgeview Publishing Company, 215-218.
- von Eckardt, Barbara (1988). "Mental Images and Their Explanations," Philosophical Studies, Vol. 53, No. 3 (May 1988): 441-460.

- Werner, A., R. Menzel, and C. Wehrhahn (1988). "Color Constancy in the Honeybee," Journal of Neuroscience, Vol. 8, No. 1 (January 1988): 156-159.
- Westphal, Jonathan (1984). "The Complexity of Quality," Philosophy, Vol. 59, No. 230 (October 1984): 457-471.
- (1991). Colour: A Philosophical Introduction, Second Edition. Oxford: Basil Blackwell.
- White, Stephen L. (1986). "The Curse of Qualia," Synthese, Vol. 68, No. 2 (August 1986): 333-368.
- (1991). The Unity of the Self. Cambridge, Mass.: The MIT Press.
- Wiggins, David (1987). "A Sensible Subjectivism?" in his Needs, Values, Truth: Essays in Philosophy of Value, Aristotelian Society Series, Vol. 6. Oxford: Basil Blackwell.
- Wilson, Mark (1988). "Nature's Demands on Language," Philosophical Topics, Vol. 16, No. 1 (Spring 1988): 285-336.
- Wright, Anthony A. and William W. Cumming (1971). "Color-Naming Functions for the Pigeon," Journal of the Experimental Analysis of Behavior, Vol. 15, No. 1 (January 1971): 7-17.
- Wright, Crispin (1988). "Moral Values, Projection and Secondary Qualities," Proceedings of the Aristotelian Society, Supplementary Vol. 62 (1988): 1-26.
- Wright, Larry (1973). "Functions," The Philosophical Review, Vol. 82, No. 2 (April 1973): 139-168.
- Wyszecki, Gunter (1986). "Color Appearance," in Handbook of Perception and Human Performance, Vol. 1: Sensory Processes and Perception, eds. Kenneth R. Boff, Lloyd Kaufman, and James P. Thomas. New York: John Wiley and Sons, Chapter 9.