

Contents

Preface to the Second Edition	<i>iii</i>
Preface to the First Edition	<i>vii</i>

Chapter 1 Science of Color Vision: A Brief History

Introduction	1
Early Greek Concepts	2
The Middle Ages	5
Kepler and the Retinal Image	9
Newton's Breakthrough	12
Toward Explaining the Appearance of the Spectrum	16
Trichromacy	18
Opponent-Color Theory	23
The Recent Past	25
Summary	29
Notes	30

Chapter 2 Subjective Color Phenomena

Introduction	33
The Colors of Objects	36
Dimensions of Chromatic Experience	39
Miscellaneous Color Phenomena	47
Summary	56
Notes	56

Chapter 3 The Visual Stimulus

Need for a Physical Definition of the Stimulus	58
Primary Stimulus for Vision	60
Light	61
Sources of Light	66
What Happens to Light When it Encounters Various Media?	70
The Fate of a Solar Photon	77
The Importance of Direction	79
Wavelength, Photon Energy, and Retinal Irradiation	84
Dispersion and Chromatic Aberration	85
Summary	89
Notes	90

Chapter 4 The Eye: Anatomy Underlying the Perception of Form and Color

Introduction	92
The Mobile Eye	94
Optical Elements of the Eye	96
The Retina	101
Summary	119
Notes	120

Chapter 5 Visual Pigments, Spectral Sensitivity, and Color Matching

Introduction	121
The Matching Operation	124
Metameric Matching and the Spectral Sensitivity of Rod Vision	125
On the Narrowness of the Visible Spectrum	130
Monochromacy and the Molecular Basis of Vision	131
Trichromatic Color Vision and its Basis	140
The Search for Cone Spectral Sensitivity Curves	145
Retinal Densitometry	147
Microspectrophotometry (MSP)	149
Suction Electrophysiology	157
Color Matching	162
The Trilinear Triangular Color Diagram Introduced	166
Data from Actual Color-Mixture Experiments	180
Spectral Absorption Curves of Human Cone Pigments	185
Summary	191
Notes	193

Chapter 6 Sensitivity Regulation

Introduction	196
Chromatic Adaptation: A Triple Problem	198
Numbers of Photons Involved	199
The Use of Background and Test Fields	200
Photography as an Analog	201
Light and Dark Adaptation	204
Bleaching and Regeneration Kinetics	208
Receptor Adaptation	214
Range of Visual Responses as a function of Luminance Range	216
Other Considerations Concerning Receptor Adaptation	224
Mechanisms of Adaptation Beyond Receptors	227
Chromatic Adaptation	228
Some Evidence for Postreceptoral Chromatic Adaptation	243
Summary	245
Notes	245

Chapter 7 The Encoding of Color

Introduction	249
Opponent-Color Theory	250
Some Methodological Notes	259
Human Visual Electrophysiology	262
Brief Tour of Color-relevant Anatomy and Physiology	264
Projections To The Brain	276
Single Unit Electrophysiology	279
Chromatic Mechanisms in the Ganglion Cells and LGN	281
Two Pathways	285
Receptive Field Organization	287
Receptive Fields and the Chromatic Code	291
Visual Cortex	296
A Summary Diagram	298
Physiologically Based Color Space	304
Summary	308
Notes	310

Chapter 8 Chromatic Discrimination

Introduction	312
Chromatic vs. Achromatic Color Differences	315
Introduction to Wavelength Discrimination	317
Theoretical Development: Preliminaries	319
Critical Questions About Chromatic Discrimination	321
Modeling Wavelength-discrimination Functions	330
Experimental Data: Chromaticity Discrimination	337
Summary	353
Notes	354

Chapter 9 Temporal and Spatial Factors in Color Vision

Introduction	357
Spatial and Temporal Behavior Related to L-, M-, & S-cones	359
Direct Heterochromatic Photometry	361
The Sensation of Flicker	364
Heterochromatic Flicker Photometry	367
Theoretical Basis of Flicker Photometry	372
Sinusoidal Flicker	374
Flicker Curves and Color Vision	384
Interactions Between L- and M-cones	386
Temporal Responses of Cones and Their Pathways	395
Color and Motion	398
Spatial Factors	399
Color Information from Edges	409
Summary	409
Notes	410

Chapter 10 Color Vision Variations

Introduction	414
Terminology	415
Variations in Normal Color Vision	416
Color vision Testing	423
The Problems of People with Color Variant Vision	441
How Color Vision Can Go Awry	442

Dichromacy on a Cone Excitation Diagram	445
Some Controversial Aspects of Red-Green Deficiency	447
What Do Red-Green-Defective Observers Really See?	452
Other Forms of Color Variance	455
Acquired Color Vision Deficiencies	458
Genetic Basis of Color Variance	461
Summary	480
Notes	481

Chapter 11 Naming, Ordering, and Recognizing Surface Colors

Introduction	485
The Nature of Surface Reflectance	487
The Continuous Yet Categorical Nature of Color	490
Color Order Systems	492
The Naming of Colors	498
Color Naming Research at the University of California, San Diego ...	500
Color Sensations and Color Naming	504
Color Constancy	507
Summary	522
Notes	523

Appendix

Introduction	525
Part I: CIE System	526
Part II: The Origins of the 1931 CIE System	534
Part III: Color Vision Mathematics: A Tutorial	544
Part IV: Cone Contrast and Opponent Modulation Color Spaces	563

References	580
-------------------------	-----

Index of Names	628
-----------------------------	-----

Index of Subjects	639
--------------------------------	-----