

Color Ontology and Color Science

Jonathan Cohen and Mohan Matthen, editors

**A Bradford Book
The MIT Press
Cambridge, Massachusetts
London, England**

© 2010 Massachusetts Institute of Technology

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.

MIT Press books may be purchased at special quantity discounts for business or sales promotional use. For information, please email special_sales@mitpress.mit.edu or write to Special Sales Department, The MIT Press, 55 Hayward Street, Cambridge, MA 02142.

This book was set in Stone Serif by Toppan Best-set Premedia Limited. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Color ontology and color science / edited by Jonathan Cohen and Mohan Matthen.

p. cm.—(Life and mind : philosophical issues in biology and psychology)

“A Bradford book.”

Includes bibliographical references and index.

ISBN 978-0-262-51375-3 (pbk. : alk. paper)—ISBN 978-0-262-01385-7 (hardcover : alk. paper)

1. Color vision. 2. Color—Psychological aspects. 3. Color (Philosophy) I. Cohen, Jonathan, 1971–
II. Matthen, Mohan.

QP483C643 2010

612.8'4—dc22

2009032012

10 9 8 7 6 5 4 3 2 1

Index

- Abramov, I., 160
- absorption, 158, 212, 250–251, 253
of light, 5, 154, 247, 249, 300, 367
- adaptation
neural, 173
of species, 21–22, 33, 195
visual, 33, 155, 169, 172, 183, 208, 308, 310, 320, 325
- Adelson, E. H., 115
- afterimages, 170, 246–247, 250–254
- Alpern, M., 167, 283, 331–332
- Alvarado, N., 186
- anomalous trichromacy, 157, 300, 313, 322–325, 334
causes of, 155–156
experiences, 327, 362–363
judgments, 364
sensations, 302, 330, 362–364
vision, 155, 235, 270
- Arend, L. E., 115, 152, 283
- Aristotle, 3, 127
- Armstrong, David, 245, 275
- attributes. *See* properties
- audition, 56, 213, 217
- Avicenna, 3
- awareness, 210–211, 223, 365
perceptual, 203–204, 216–219
- Barbeito, R., 156
- Barlow, H. B., 168
- Berkeley, G., 336
- Berlin, B., xv, 180, 186
- Bixby, F. L., 140
- blindness, 270
- blindsight, 203–205, 209, 211, 219
- Bloj, M. G., 171
- Bollo, F., 309
- Bone, R. A., 356
- Bonnardel, V. A. L., 267
- Boyle, R., xvi, 229
- Boynton, R. M., 184, 239, 260, 268–269, 295–297, 317, 319, 333–334, 375–376
- brain, 125–127, 130, 161, 163, 169–172, 251
in a vat, 68
damage, 204
development, 39, 136–137
and judgments, 21, 361
and perception, 10, 18, 38, 74, 151–152, 156, 159, 164
processes in, 265, 291, 368, 373
and representation, 39–41
state, 164–165
- Brainard, D. H., 171
- Brettel, H., 260
- brightness, 52, 60, 106, 141, 320, 332
perceived, 30, 342
as a dimension, 19, 32–33, 48–49, 61–62, 91, 93–94, 110, 114, 123, 251–252, 306, 309, 372–373
of stimuli, 152, 170, 264, 316, 331
variation of, 187, 293, 302–303, 312
- Brindley, G. S., 102

- Britten, K. H., 165
 Broadbent, D. E., 213
 Broad, C. D., 208
 Broackes, Justin, xix–xx, 246
 Brown, Richard, 180, 186, 195, 324–325
 Bühler, Karl, 92, 115, 123, 138–139
 Bülthoff, H. H., 139
 Byrne, Alex, xviii–xix, 63–64, 75, 87, 131, 167, 229, 231, 246, 249, 280
- Cains, A., 356
 Campbell, J., 215, 245
 canonical approximations, 43, 46–57, 62–63
 Cao, D., 154
 Carroll, J., 157, 168
 Cassirer, E., 139
 categories, 74, 76, 106, 125–126, 136
 color, 3, 19, 81, 101, 131, 138, 163, 179–196, 309–310, 322
 innate, 134
 judgments, 20–21, 236
 perceptual, 128–129, 133, 186
 phenomenological, 219, 254
 private, 69
 certainty
 empirical, 68–69, 71, 73
 Cartesian, 69–74, 76, 80
 Chalmers, David, 153, 206
 Chevreul, Michel, 268
 Chisholm, R., 207, 220
 Chomsky, Noam, 86, 125
 chroma, 7, 12–13, 19, 22–25, 31–33
 chromaticity, 21, 342–344
 diagrams, 13, 15, 105, 168, 261–265, 271–273, 302–319, 347–350, 359, 371
 space, 309–310, 315, 320, 331
 Churchland, Paul, xi–xiii, 69, 85
 Cicerone, C. M., 168, 184
 Clark, Austen, xv, 208, 246
 Cohen, Jonathan, xvi, 72–73, 115, 131, 229, 232, 238, 246
 Cohen, J. B., 16
 Collins, Mary, 375
- color blindness, 57, 173, 291–295, 304–308, 360–367. *See also* anomalous trichromacy; dichromats
 behavior, 60, 267, 296
 experience, 296
 in one eye, 321–332
 sensations, 166–169, 259–264
 types, 264–266, 298–302
 color coding, 50, 61, 123–124, 137
 Hurvich-Jameson, 42–44, 51
 neural, 160, 166
 predictive, 170–172
 primary, 97–102, 105, 108
 color differences, 24–25, 29–31, 57, 63, 83–84
 suprathreshold, 21, 31
 color matching, 87, 92, 94–95, 100–101, 106, 112–113, 154–155, 167, 301–302, 316, 369
 experiments, 261–264, 272, 292, 333–334
 functions 12, 32, 304–308, 312, 342, 357–358
 color ordering, vii–x, 3–4, 9, 19, 21–22, 31–32, 295
 color solid, 3–6, 11–16, 21–27, 30–34, 40–42, 47–48, 51, 61–62, 69, 85, 94, 114, 294
 color space, ix–x, 14–16, 18, 22–29, 43–46, 86, 91–94, 112. *See also* color blindness; sensory systems; trichromacy
 CIE space, 13–17, 30–51, 52, 103, 181–182, 186, 262–263, 344, 352–356
 dimensions of, 3–10, 12–13, 18–19, 31–33, 40–42, 91–117, 123–124, 159, 162–164, 209, 262–263, 271, 340, 346–356, 374
 phenomenological, 40–42, 46–54, 62–63
 color vision, x, 4–5, 9–10, 21, 60, 67–88, 91–98, 115–117, 151–154, 168, 310, 369, 376–377
 nonhuman, 15, 84, 274, 282, 291
 phenomenology of, 115, 251
 physiology of, 29, 98, 160–163, 172, 332
 systems, 18, 33, 38–40, 43, 46, 49–52, 57, 61–64, 80–81, 114, 133, 139, 151, 157, 160, 163, 166, 179, 194, 235–237, 291, 304, 309, 312, 325, 340
 variations in, 230–231

- colors
 distinguishing between, 5, 22, 38, 63, 171, 337–340
 Hering, 180–186, 189–196
 mixed, 54–55, 292
 objective, 37–41, 46, 50–52, 55, 57, 62–64, 131, 232
 primary, 31, 85, 159–161, 164, 166
 pure, 55, 160, 162, 166–168, 190–191, 194, 293, 303, 304, 331–332, 341, 348, 350, 365–366, 371–372
 as properties, x, 64, 74–75, 91, 123, 131, 137, 229–232, 275, 280
 self-luminous, 52, 60–63
 unique, 18, 182–195, 230–231, 270–271, 274–283, 293, 315, 321, 323, 338–340, 365, 371
 Commission Internationale de l'Éclairage (CIE), 12, 30–31, 97, 304–308, 329, 342.
 See also chromaticity; color space
 concepts. *See* categories
 conditioning, 82–86
 cones, 9–10, 29, 38, 154, 158, 166–168, 261–270, 282, 300, 312, 334–337, 355–357, 376
 activation, 24, 44, 61–63
 excitation, 156–159, 163, 169
 L cones, 51, 156–157, 160, 344, 368
 M cones, 51, 160, 368
 photoreceptors, 151–159, 163, 167, 169–170, 212, 265, 335–336, 354–355, 376
 S cones, 302
 sensitivity, 9–14, 16, 29, 32–33, 42–44, 49–52, 160
 confusion lines, 264–265, 312–321, 331, 371
 consciousness, 203–206, 211, 220–223
 constancy, 325
 chroma, 8
 color, 22, 94, 114, 169–171, 309, 354
 contrast, 22, 103, 170, 324
 Cook, R. S., 179–180, 183, 185–186, 189
 Cooper, L. A., 266–267
 Cornsweet, T. N., 170
 Cottaris, N. P., 156, 159, 161, 163
 Cowey, A., 204–205, 209
 Crane, H. D., xviii, 69, 250
 Crick, F., 156
 Crognale, M. A., 295, 335
 Crozier's law, 165

 D'Andrade, R. G., 183
 D'Zmura, M., 192
 Dacey, D. M., 154, 159, 169
 Dalton, John, 260–261, 266–267, 294, 295, 297–298, 321, 326, 362, 375, 377
 Davidoff, J., 179, 186
 Davies, I. R. L., 186
 De Valois, K. K., 29, 291, 293
 De Valois, R. L., 29, 156, 159, 161, 163, 291, 293
 de Weert, C. M. M., 21
 Dedrick, Don, 246
 Deeb, S. S., 300
 demonstratives, 215, 219
 Dennett, Daniel, 222
 denotation. *See* semantics
 depth, 135, 138, 140, 152, 336
 Derrington, A. M. J., 159, 181
 Desbordes, G., 170
 Descartes, R., 69, 128, 151–152, 336. *See also* certainty
 deuteranopes. *See* dichromats
 dichromats, 259–260, 267–270, 274–283, 295–302, 304, 315–317, 320, 333, 340, 344, 352, 358, 372. *See also* color blindness
 causes of, 330, 332, 336
 color space of, 266, 270–273, 281, 293, 296
 experiences of, 269, 276, 281, 294, 310, 321–327, 332, 335, 346, 363, 368, 373
 gamut, 270–273, 324–325
 judgments of, 296, 337, 361
 perceptions of, 292, 310, 312, 322, 326, 355, 361
 representation in, 259
 sensations of, 259, 266, 296, 317–318, 330–331, 361, 367–368, 377

- discrimination, 56–57, 61–63, 204, 209, 220, 222. *See also* just noticeable differences
of colors, 160, 164–166, 194, 204–205, 265, 298–300, 355
limits, 53
dispositionalism, 71–72, 77, 131, 232
Dkhissi-Benyahya, O., 154
Dove, H. W., 139
- Ecker, J. L., 154
eigenvectors, 6–8, 15–16
space, 8–9, 10, 13
Ekroll, V., 111, 115, 124
electromagnetic energy, 4, 9–10, 29, 37–38, 56, 80, 250, 252
eliminativism, 38, 55–56, 229–230, 240–241, 274
Engel, S. A., 164
Enroth-Cugell, C., 170
error, 32–33, 140, 273–274, 280–282, 326. *See also* hue misperception
Estévez, O., 318
Euclidean space, 3, 8–10, 16, 19, 21, 24–25, 33, 114
Evans, Gareth, xiv, 92, 94, 96, 115, 140
evolution, 9, 16, 33, 274
of the perceptual system, 60–61, 136–137, 195, 354–355
experience, 171, 309, 329. *See also* color
blindness
color, x, 18, 27, 37, 67–70, 75–88, 103, 172, 278, 312, 325, 335, 365
hallucinatory, 69, 73–74
phenomenal, 127, 131, 136, 161, 166, 169, 179, 206
sensory, 83, 131, 151, 185, 203, 222, 277, 296
external
aspects of color, 91, 106
objects, 37, 74, 78, 84
world, 67, 87, 132, 134, 136, 169, 171–172
externalism, 129, 131
- Farnsworth, D., 303, 318, 326, 330
Farnsworth-Munsell tests, 266–267, 295–296, 301, 326, 373
Faul, F., 325
Fechner, G. T., 20, 30
Felleman, D. J., 153
Ferber, S., 170
Fisher, M. P., 293
Fleming, R. W., 139
Fodor, J. A., 213
Frege, G., 85
Freud, S., 221
Fuchs, Wilhelm, 363
- Galileo, 229
Gelb, Adhémar, 92, 115, 123, 137–138, 363–364
genetics, 9, 33, 77, 320–321, 354, 370, 377
of anomalous vision, 151–158
of cone types, 18
Gerhart, J., 127
Gibson, B. S., 116
Gilchrist, A., 115
Goldschmidt, R. H., 322
Gordon, J., 160
Graham, C. H., 315, 318, 330, 333
Granit, R., 291
Grassmann, H. G., 11–12, 97, 101, 155, 304–306
Grégoire, G., 19, 22
Griffin, L. D., 52, 180
Guild, J., 304
Guler, A. D., 154
- Hacker, P. M. S., 266, 275
Hård, A., 181
Hardin, C. L. ix, x, 172, 191, 204, 211, 229–230, 237, 245, 254, 260, 277, 279
on color categories, 179, 183, 185
on eliminativism, 38, 55, 64, 274
on physicalism, 230–232, 241, 275
on reflectance profiles, 50, 52–54
on relationalism, 232–235, 239–240
on vision, 41, 50, 268–269

- Harrower, M. R., 132
Hartline, H. K., 291
Hartwell, L. H., 127
Hayek, F. A., 165–166, 169
Hayes, Samuel, 321, 325, 327, 329–330, 375
He, S., 160, 169
Hebb, D. O., 169
Heeley, D. W., 181, 192
Heggelund, P., 92
Helmholtz, H. von, 29, 93, 115–116, 139,
151–152, 160, 170–171, 291–294, 298, 340,
378
attributes, 19, 33
on color blindness, 300, 302, 312–315, 323,
327, 331, 367, 375
on opponency, 14
sign theory, 128, 133
Helson, H., 310
hemineglect, 204, 211, 219
Hendry, S. H., 159
Hering, Ewald, xiii, xix, 27, 115, 138–140,
185–186, 189, 340
attributes, 21–22, 32–33
on color blindness, 322–323, 327, 330–331,
367
on opponency, 179–184, 190–196, 291
on perception, 14, 19, 292–294
Herschel, John, 375
Hess, C., 322, 330
Hesselgren, 27
Heyer, D., 116
Hickethier color atlas, 31
Hilbert, David (mathematician), xvii
Hilbert, David (philosopher), xvii–xix, 63–64,
75, 87, 131, 167, 229, 231, 246, 249, 275,
280
Hinzen, W., 134
Hippel, A. von, 321–324, 329–330
Hochegger, R., 140
Hofer, H., 159
Holmgren, F., 323–324, 329–330
Hopfield, J. J., 127
Houston, R. A., 375
Hsia, Y., 315, 318, 330, 333
Hubel, D. H., 163, 239
hue, 19, 21, 28, 31–33, 48, 57, 61, 63, 69, 75,
85–88, 91–94, 123, 252, 260, 263–266, 271,
280, 291–296, 304–306, 312–313, 320, 323,
327, 331–333, 346, 350–351, 371–372,
375–376
circles, 7, 22–24, 105, 168, 184, 191, 194,
268, 279
misperception, 273–275, 278, 281–282
saliency, 180, 190, 192–194,
scales, 3, 20
superimportance, 21, 24–25, 31
unique, 14, 18, 22, 27, 181–195, 340
Humphrey, G. K., 170
Hunt, D. M., 294, 304, 306–308, 318, 338, 340
Hurlbert, A. C., 170–171
Hurvich, Leo, viii, ix, xix, 180–181, 183, 191,
239, 266–267, 269, 291, 294–296, 312, 315,
333, 373, 375
illusions, 86, 127, 131, 260–261, 335
impossible shades, 80, 87
intensity. *See* saturation
irrealism. *See* eliminativism
Ishihara, S., 301
isotropic systems, 21, 24–25, 27, 31–34
Jackson, F., 131, 270
Jacobs, G. H., 274, 282
Jameson, Dorothea, viii, ix, xix, 180–181,
183, 191, 194, 239, 266–267, 291, 294,
295–296, 312, 333, 373, 375
Jameson, Kimberly, xi, xv, 185–186, 192, 194,
196
Johansson, 27
Johnson, E. N., 163
Johnson, W. E., vii, ix
Johnston, M., 232, 275
Jordan, G., 184
Judd, D. B., 24–25, 27, 29, 268, 270, 292,
298–299, 304, 310–313, 315, 317, 321–323,
325, 327–331, 375, 377

- just noticeable differences, 20–21, 24, 29, 165, 265
- Kaiser, P. K., 260, 268–269
- Kappauf, W. E., 16
- Kardos, Ludwig, 123, 138
- Katz, David, 92, 115, 123–124, 137–139, 364
- Kay, P., xv, 179–180, 183–186, 189–190, 194–195. *See also* World Color Survey
- Kempton, W., 179
- Kersten, D., 171–172
- Khetarpal, N., 195
- Kirschmann, 139
- Kirschner, M., 127
- Kitahara, K., 167
- Klotz, M., 19, 22
- Knoblauch, K., 165, 192
- knowledge, 78, 83, 132
of colors, 68–74, 76–77, 79–80, 85–87, 231, 275, 277, 280, 336
innate, 86, 139
perceptual, 134, 137, 139
of the world, 40, 78
- Koch, C., 156
- Koenderink, J., 13, 16–17
- Koffka, K., 123, 132, 138, 152, 362
- Kolb, H., 153
- Komarova, N. L., 194, 196
- Kornerup, A., 31–32
- Krantz, D. H., 97, 101
- Krastel, H., 270
- Krauskopf, J., 15, 156, 159, 161, 163, 181, 192
- Kries, J. von, 115, 315, 322, 327, 329–330, 375
- Kuehni, Rolf, viii, xi, 85, 179–182, 184, 186–190
- Kuffler, S., 291
- Lambert, J. H., 3, 31
- Laming, D. R. J., 21
- Land, Edwin, 169, 309–311, 354
- Landrum, J. T., 356
- language, 18, 72, 77, 80, 86, 132, 210, 214.
See also categories
of color, 19, 123–124, 140–141, 166, 235, 260–261, 266–267, 283
color naming, 183–186, 190–191, 194–196, 333–334
cross-cultural comparisons of color, 179–180, 183, 185–196
- Le Grand, Y., 165, 312, 315, 355
- Lee, B. B., 169
- Leibler, S., 127
- Lennie, P., 15, 156, 161, 163, 166–168, 270, 331
- Leslie, A., 137
- Levi, D., 156
- Liao, H. W., 154, 159
- light, 4–6, 19, 20–21, 23, 30, 33, 64, 91, 95–110, 139, 141, 152, 247–253, 297, 334, 355. *See also* absorption; reflectance; spectral light; wavelengths
colors and, 24, 26, 31, 57, 75, 92–93, 153–156, 168–169, 191, 267, 337–340
luminance, 12–18, 104–106, 110, 114, 139, 204–205, 306–308, 320, 332, 342–352, 359–360
mixing, 52, 259, 291, 298–305
monochromatic, 61, 76
polarization of, 84
sensors, 9, 12, 171–173
- lightness, 3, 12, 18–33, 52, 114, 163, 169, 171–172, 260, 296, 313, 326, 340, 350–353, 362
- Linberg, K. A., 153
- Lindsey, D. T., 180, 186, 195
- Livingstone, M., 163
- Locke, John, xvi, 37, 64, 229
- Logvinenko, A. D., 113–114, 116
- Longere, P., 174
- luminosity. *See* brightness
- Luther, R., 14–16
- MacAdam, D. L., 13, 29
- MacEvoy, Bruce, 182

- MacLaury, R. E., 186
- MacLeod, Don, xi, xvii, 85, 98, 115, 158, 160, 166–169, 171, 270, 324–325, 331
- macular pigmentation, 318–320, 356–358
- Malkoc, G., 179, 184, 192, 194
- Maloney, L. T., 113–114, 165, 354
- Mandler, M. B., 181
- Marrocco, R. T., 170
- Martin, M. F., 138
- Martinez-Conde, S., 282
- Matthen, Mohan, xiii–xiv, xvii, 131, 232
- Mausfeld, Rainer, xiv, 115, 130, 133–134, 137–138
- Maxwell triangle, 302, 304, 306, 308
- Maxwell, J. C., 14, 19, 31–32, 131–132, 291–292, 298, 300–302, 304–305, 315, 319–320, 361, 375, 378
- Mayer, Tobias, 3, 31, 291, 304, 308, 340
- McCann, J. J., 169
- McCollough, C., 163, 168
- McDowell, J., 234
- McGinn, C., 232
- McLaughlin, Brian, 72–74, 131
- memory, 69, 215
- mental states, 136–137, 203, 220–222
- Merbs, S. L., 155, 166
- metamers, 8, 11, 22, 38, 43, 51–61, 63, 82, 96–99, 262, 264, 301, 346
- acoustic, 56
- diversity of, 39
- Metelli, F., 253
- Methuen Handbook of Colour*, 31
- Miyahara, E., 184, 192
- Mollon, J. D., 155, 170, 184, 190, 192, 300
- Monge, G., 170
- Montag, E. D., 295, 333–334, 376
- Moreland, J. D., 270
- Mothersill, M., 233
- Müller, G. E., 29, 161–162, 164–166, 169, 291
- Munsell, A. H., 19, 22, 32, 46, 51, 325–326.
- See also Farnsworth-Munsell tests; hue circles atlas system, 18–19, 22–27
- Book of Color*, 186
- color chips, 6–7, 13, 230
- reflectance functions, 7
- renotations, 24, 31
- Murray, A. W., 127
- Murray, S. O., 172
- Nagel, Thomas, 206, 221
- Nagel, Wilibald, 295–298, 300–303, 313, 320–333, 362, 375, 377
- Nagy, A. L., 155, 168, 295, 333–335, 376
- Nathans, J., 155, 166, 299–300
- Natural Color System, 22, 27–28, 262
- natural science, 124–126, 134
- Nayatani, Y., 181
- necessity, 80–81, 246, 249–250, 275
- Necker, L. A., 362–363
- Neisser, Ulric, 128, 213
- Neitz, J., 158, 168, 295, 299–300
- Neitz, M., 158, 295, 299–300
- Nerger, 168
- nervous system, 55, 164, 167, 211–212, 214–215
- neurons, 15–16, 51, 55, 61, 153, 156–160, 162–165, 168–169, 173, 213
- Newsome, W. T., 153
- Newton, I., 4, 14, 19, 21, 42, 153, 156, 304, 377
- Nickerson, D., 24, 27, 186
- Niederée, Reinhard, x, xiii, 85, 115–116, 124
- night vision, 9, 310
- Nuberg, N. D., 318–319
- O'Regan, J. K., 179
- objectivity. See reality
- Olson, C. X., 184
- opponency, 291, 294, 312
- colors, 173, 179–184, 190, 192, 194–195, 205, 261, 268,
- functions, 15–16
- models, 42, 274, 278–282
- physiology of, 33, 38, 44–45, 54, 159–163, 167, 183, 239, 246, 268–269, 336, 368
- space, 14–17, 61–63

- Optical Society of America, 24–27
- Osorio, D., 195
- Ostwald, W., 27, 293
- Otake, S., 184
- Palmer, S. E., 166, 168, 294
- Parker, A. J., 153
- Pascual-Leone, A., 172
- Peacocke, C., 232
- perception, 5, 8, 33, 92–96, 99, 101, 111, 203–204, 221. *See also* categories, perceptual; dichromats, perceptions of; experience, sensory; hue misperception; representation, sensory
- of color, 12, 18–24, 27–32, 87, 114–117, 152, 168, 179, 192–196, 237, 240–241, 252–253, 281–283, 297–298
- information, 211, 213, 218, 220, 222
- judgments, 13, 91, 97, 208
- relations of, 67, 169–170, 231, 235
- states, 79, 83, 88, 206, 214
- systems, 22, 24, 64, 123–141, 230
- theory, 14, 123–141, 152–167, 171–173, 211–212, 277, 279
- variation in, 27, 29, 87, 230–232, 237
- Philipona, D. L., 179
- photoreceptors. *See* cones
- physical science, 37. *See also* natural science
- physicalism, 75–77, 131–132, 229–232, 241, 249–250, 275. *See also* surface reflectance
- physics, 27, 64, 75–76, 85, 124, 250, 252
- Piantanida, T. P., xviii, 69, 250
- pigments, 22, 24, 154–155, 157–158, 166–167, 274, 334, 340–347, 348–349, 352
- Pitt, F. G. H., 312–313, 315–320, 332, 375–376
- Plato, 55, 127, 234–235
- Meno, 234–235, 237–239
- Pokorny, J., 98, 154, 295, 297, 303, 318–319, 333–334
- Pole, William, 268–269, 321, 362, 377
- primary quality theories of color, 75, 80–81, 86–87
- processing, 132, 212–218, 222–223, 270
- color, 38, 49, 113, 162, 167, 180, 190, 192, 194, 270, 282, 291, 294, 304
- information, 61, 77, 84, 128–129, 207, 211, 354
- neural, 18, 98, 155–157, 159, 166–167, 169–170, 172, 181, 330, 373
- perceptual, 194–196, 206, 211, 279
- visual, 29, 94, 151–152, 179, 181, 183, 195, 282, 332
- properties, 63, 71, 75–78, 88, 130, 136, 171, 179, 215, 231–235, 259. *See also* colors as properties
- of color, 60, 62, 64, 67, 81–82, 84–85, 123–124, 137–141, 240–241, 275
- monadic, 38
- necessary, 81
- primary, 37, 67, 75–78, 131, 136
- phenomenal, 37, 166, 205–211, 220–221
- Protagoras, 74
- protanopes. *See* dichromats
- psychology, vii–viii, xx, 4, 123, 127, 130, 205–206, 214, 298
- cognitive, 212–213
- experimental 4, 30
- folk, 126, 213
- perceptual, 123–125, 127, 132–133, 137–139
- psychophysics, 20, 22, 27, 84, 91–92, 94, 152, 161–162, 164–165, 168–169, 250, 252–253, 291, 377
- Putnam, Hilary, 245, 254
- Pylyshyn, Z., 215
- Pythagoreans, 127
- qualia, 205–207, 209–211, 297, 368
- Radde's scale, 324
- Raker, V. E., 184
- Rayleigh, 301, 333–334
- realism, 41–42, 54–56, 126, 131, 134
- color, 42–43, 48, 91, 116, 153, 183, 230, 232, 239–240
- naïve, 128–130
- pluralistic, 84–85, 131

- Reeves, A., 115, 152, 283
reference, 78, 115–116, 129, 215
reflectance, 5, 12, 22, 93, 169, 185, 368. *See also* spectral light reflectance; surface reflectance
functions, 6–8, 13, 18, 308
luminous, 19, 30
physicalism, 249–250
profiles, 38–63
Regan, B. C., 195, 354
Regier, T., 179–180, 183, 185–186, 189, 195
Reid, R. C., 159
relationalism, 72–73, 77–78, 229–241
representation, 33, 40, 94, 156, 169–172, 222–223
of colors, 41–42, 45–46, 50, 52, 61–62, 67–88, 115–116, 131, 151–153, 159, 161–163, 181, 187, 230–231, 280, 282
sensory, 4, 24, 67–88, 130, 213, 215, 217–219
spectral, 11
retina, 15, 18, 42, 96, 98–99, 151–153, 169, 294, 312, 320, 323, 330, 335, 354–355, 363.
See also cones
Rey, G., 214
Rieux, C., 154
Roberson, D., 186
Rock, I., 116
rods, 154, 158, 310, 320, 334–335, 376
role functionalism, 232, 238
Rossotti, H., 293
Rowe, M. P., 274
Rucci, M., 170
Ruddock, K. H., 270
Russell, B., 129

Salzman, C. D., 153
Santos, L. R., 137
saturation, 19, 22, 32–33, 47, 50, 57, 61, 63, 75, 85, 91, 93–94, 123, 251–252, 260, 263, 265–266, 273, 292, 295, 304–306, 312, 324, 326, 328, 332–333, 346, 370–372
maximal, 27, 310
Sayre-McCord, G., 234

scaling
color, 20, 22, 27, 31
lightness, 19
multidimensional viii, 21, 113, 226
partition, 21
Scandinavian Colour Centre, 27
Scheibner, H. M. O., 295–296, 317, 319, 333–334
Schmidt, I., 326
Schrater, P., 172
Schumann, F., 362
Scott, J., 294, 321
Searle, J., 206
secondary quality theories of color, 70–75, 77, 84–85, 87
Seebeck, A., 361
selective attention, 212–220, 222–223
semantics, 40
of color, 67, 77–88
denotation, 67, 77–80, 85
sensations, 55, 161, 165
of color, 37, 51–52, 63, 70–71, 80, 87–88, 92–93, 115, 327, 332, 365
of depth, 336
visual, 38
sensory systems, 40, 80, 134–136, 221, 296, 324, 370. *See also* perception systems; visual systems
Shadlen, M. N., 165
Shady, S., 160
Shapley, R. M., 170
Sharpe, L. T., 308, 315, 356
Shepard, R. N., 266–267
similarity, 39, 50, 79, 164–165, 208, 296
color, 42, 76, 81–85, 173, 179–180, 185, 261, 266–267, 275, 295, 301, 373
relations, 40, 67, 69, 71, 240
spaces, 79, 83, 85–88, 267
Simon, C. P., 101
Singer, B., 159
Sivik, L., 181
Sloan, L. L., 270, 322, 325–326, 330, 333
Smart, J. J. C., 245, 251
Smith, V. C., 98, 295, 297, 318–319, 333–334

- Sober, E., 234
- spectral light, 22, 30, 47, 61, 105, 155, 264, 273, 295, 301, 304, 313, 325
- reflectance, 5–6, 33, 154, 230, 249, 340–341, 366
- sensitivity, 9–10, 155, 158, 160
- spectral power distributions (SPDs), 4–13, 16, 18, 22, 29, 33, 308, 338
- Sperling, H. G., 270
- Stalmeir, P. F. M., 21
- Stevens, S. S., 20
- Stiles, W. S., 93, 298–300, 308, 315, 317–319, 338, 340, 352, 356–357, 371
- Stilling, J., 301
- stimuli
- achromatic, 15, 114
 - color, 3–6, 11–14, 18–19, 22, 27, 33–34, 154, 167–168, 190, 363
 - distal, x, 169
 - large isolated patches, 99, 102, 105–106, 108, 110
 - monochromatic, 42, 299
 - physical, 20, 185–186, 264
 - proximal, 91, 93–94, 99, 152, 169
 - surround, 27, 31, 33, 92–103, 107–108, 110–111, 113, 124, 159, 252–253, 295, 320
- Stockman, A., 160, 308, 356
- Stoerig, P., 137, 204–205, 209
- Strawson, G., 134
- surface, 37, 41, 56, 60, 152, 247, 253, 295, 346, 366
- color, 75, 93–94, 114–116, 138, 333
 - reflectance, 230, 249–250, 308
- SurrIDGE, A. K., 274
- Svaetichin, G., 291
- tetrachromacy, 157
- Theophilus, 3
- Thompson, Evan, 232, 246
- Thouless, R. H., 152, 171
- Titchener, E. B., 32
- Todorović, D., 116
- trichromacy, 92–93, 114, 151. *See also*
- anomalous trichromacy; evolution of the perceptual system
 - extended, 98–112
 - theory, 14, 172, 291
- trichromats, 76, 92–93, 97–101, 108, 112, 168, 209, 230, 259, 266–269, 271, 273–275, 279–283, 293–295, 298, 310, 312–313, 315, 317, 337–346. *See also* color vision; experiences, color; physiology of, 9, 64, 154–160, 261–264
- tritanopes. *See* dichromats
- truth, 80, 88, 130, 246–247, 250
- analytic, 69, 79–80, 83, 86
- Tye, M., 229, 231, 274
- UK National Physics Laboratory, 317
- Urfarben, 14, 181. *See also* Hering, Ewald
- van Doorn, A. J., 16–17
- Van Essen, D. C., 153
- Viénot, F., 260
- viewing conditions, 29, 68, 71–73, 96, 103, 139, 230–231, 237–239, 272
- von der Twer, T., 160
- Vorobyev, M., 195
- Vos, J. J., 318–319
- Vul, E., 160
- Walls, G. L., 310
- Walraven, P. L., 318–319
- Walsh, V., 172
- Wanscher, J. H., 31
- wavelength productance, 75–76, 80–81, 85–87, 96
- wavelengths, 4, 49, 52, 57, 96, 308, 316, 342
- color and, 75–76, 80, 82, 84, 92, 99, 166–167, 230, 273–274
 - light and, 4–7, 9–12, 42, 153, 155, 249, 261–264
 - sensitivity, 9, 38–39, 42, 44–47, 205, 300, 304–306, 356

- Weber-Fechner law of logarithmic relationship, 27
- Weber, E. H., 20, 30
- Webster, M. A., 158, 179, 183, 192, 194
- Weiskrantz, L., 204–205, 207, 209
- Westland, S., 253
- Westphal, Jonathan, xvii–xviii, 249–251
- Wheatstone, C., 336
- Whittle, P., 165
- Williams, D. R., 159
- Willis, M. P., 303, 330
- Wilson, George, 297–298, 375
- Wittgenstein, viii, xvii, 245–247, 249, 254
- Wollach, L., 270, 325–326, 330, 333
- World Color Survey, xv, 179–180, 186–190, 193, 195
- Wright, W. D., 301–302, 304–305, 308, 315–316, 375
- Wundt, 139
- Wyszecki, G., 93, 298–300, 307–308, 315, 317–319, 338, 340, 352, 356–357, 371
- Young, Thomas, viii, 14, 98, 291
- Yuille, A., 171
- Yustova, E. N., 318–320
- Zangwill, N., 233
- Zelanski, 293