

CONTENTS

I	INTRODUCTION: HOLES IN A FLUX	I
1	Light. Energy and least action.	I
2	Shadow. A confusion of terms. Three kinds – projected shadow (some cast, some attached), self-shadow (also attached), shading from tilt and slant.	2
3	A short glossary for light behaviour: lights, illumination, and reflection from surfaces.	4
4	The retinal array. Luminance discontinuities and their several causes. The perceptual task.	8
5	Piazzetta, <i>A Man with a Staff</i> : kinds of shadow.	12
II	ENLIGHTENMENT SHADOWS	17
6	John Locke: experience of flat circles variously coloured. Settled habits of inference. Molyneux's Query: sphere and cube.	17
7	Leibniz and Berkeley: the epistemological resonances of shadow.	20
8	Cheselden's Case and the thickening of the Query.	22
9	The French extension. The sensational statue of Condillac.	25
10	Three Enlightenment shadows: Montesquieu, the Abbé Millot, Rousseau.	28
III	SHADOW AND INFORMATION	32
11	Subleyras, <i>Charon</i> : three Queries.	32
12	Three questions. Machine vision and shadow. The recalcitrance of shadow.	35

CONTENTS

I 3	The issue of importance. Pro: counter-shading, and light-from-above hard-wiring. Con: overridden shadow, and confusing shadow. An agenda: relationality and the top-down.	36
I 4	Modular early vision. The supercontingency of shadow. Reducing the relations: 'shape-from-shading'. The attenuations of one-to-many. Serial and parallel.	41
I 5	Top-down perception. An impossible drawing by Tiepolo – the mannekin and the paper bag. Top-down versus bottom-up.	48
I 6	Middle perception: the predominance of shadow edges. Some active properties of the retina – mobility and the registration of change; variable thresholds; plotting discontinuity.	52
I 7	The parabolic lines of Koenderink and van Doorn.	56
I 8	Cast shadow: shadow in need of support. Inferred source or seen surface. Waltz's illuminated block-world. Shadow as constraint, as line, and as surface.	60
I 9	Illumination and reflected luminance: sliding scales and differentials. The passivity of fields. The logic of lighting. Gilchrist's rooms.	66
I 20	Summary.	70
I 21	Introspection.	72
IV	ROCOCO-EMPIRICIST SHADOW	76
I 22	Two kinds of chiaroscuro: prescriptive-compositional and analytical. Compositional chiaroscuro epitomised: ten points from D'André-Bardon.	76
I 23	Analytical chiaroscuro: a shadow agenda from Jombert-Cochin: (a) edges of shadows, (b) form of shadows, (c) light conditions and shadow, (d) relative intensity of shadows, (e) colour in shadow, (f) colour of shadow.	77
I 24	(a) <i>Edges of shadows</i> : Conceptions of light–particles and fluids. Two relevant behaviours: reflection and diffraction. Grimaldi and diffraction. The prospect for edges.	80
I 25	(b) <i>Form of shadows</i> : Sciography. Mathematical truth and physical truth. The appeal and limitations of sciographical shadow. Its postulates and product. Testimony of 'sGravesande.	84

CONTENTS

xi

26	The observational alternative of Maraldi. A flame-like form with a structure. The fluid model.	88
27	(c) <i>Light conditions</i> : Directed light and diffused light. Gautier D'Agoty and Oudry. Some reflections. An idea adapted by Diderot?	91
28	The photometers. Lambert and diffused shadow. Light through a doorway. Shadow on a cloudy day. Horizon, and angle of incidence.	99
29	(d) <i>Intensity</i> : Cochin's wall (i): shadow as object. The ballistics of reflection. The darkness of cast shadow. Three kinds of light in one complex.	104
30	Cochin's wall (ii): shadow from a point of view. Two counter-scales and a variable point of balance.	108
31	(e) <i>Colours within shadow</i> : Attenuation of colour. The persistence of hue as opposed to tone. Reflected hues: an exhortation from Diderot.	110
32	(f) <i>Coloured shadow</i> : Buffon's observation. Physical explanation: Bouguer on differential scattering, and Léonard de Vinci.	112
33	Subjective explanation: Otto von Guericke's candle. Simultaneous contrast versus colour constancy.	115
V	PAINTING AND ATTENTION TO SHADOWS	119
34	Summary. Systematic shadow and syllogistic shadow. (A list of some possible shadow perceptions.)	119
35	Thomas Reid and the perceptual transparency of shadow.	124
36	Attention and the painter.	127
37	Oudry, <i>Hare, Sheldrake, Bottles, Bread and Cheese</i> .	130
38	The ecological validity of painting. A market in attention.	134
39	Largillierre and pseudo-opticism. Pictures as performances of representation.	136
40	Chardin, <i>The Young Draughtsman</i> .	139
41	Conclusion.	143
	APPENDIX: THREE NOTES ON LEONARDO AND EARLY RENAISSANCE SHADOW	146
I	The renaissance of rilievo.	146

CONTENTS

2	The analytic of drawing: second derivatives on a zero-ground.	149
3	Leonardo da Vinci on shadow in 1490–93.	151
	NOTES AND TEXTS	156
	BIBLIOGRAPHY	180
	INDEX	189
	PHOTOGRAPH CREDITS	193

INDEX

- Al-Bīrūnī 169n
anisotropic surface 7, 97, 131, pl. ix
astronomy 46, 84, 112
atmosphere 5, 96, 104, 108–109,
113–117, 123–124, 139,
152–153, 167–168n
attention 18, 35, 40, 77, 119,
127–128, 135, 140, 142,
177–178n
- Bartolozzi, Francesco 12–14, fig. 5
Berkeley, George 20–22, 26
Blinn, J.F. fig. 3
Bosse, Abraham 170n
Botticelli 149
Bouguer, Pierre 6, 97–99, 108, 111,
113, 115–117, 119, fig. 28
Buffon, Georges-Louis Leclerc, comte
de 26, 29, 112–113, 119, 176n
- Caravaggio 95
Cavalieri, Bonaventura 97, 173n
Cennini, Cennino 148–149
Chardin, Jean-Siméon 111, 132, 137,
139–142, pl. iv, pl. x
Cheselden, William 22–25, 27, 134,
fig. 8
chiaroscuro/clair-obscur 16, 59,
76–77, 88, 96, 106–107, 140, 142
Cochin, Charles-Nicolas, the
Younger 78–79, 104–110, 115,
119, 121, 123–124, 130–131,
136–139, 153, 169n, 177n,
fig. 31, fig. 33, fig. 35
colour 30, 78–79, 81–82, 110–111,
112–117, 142, 148–149,
167–168n, 173n, 178n, fig. 25
Condillac, Etienne Bonnet de
26–28, 30, 56, 119, 177–178n
- Dandré-Bardon, Michel-François
76, 104, 164n, 178–179n
Daniels, Charles 179n
Desargues, Girard 85–86
Diderot, Denis 26, 30, 96–99,
110–111, 119, 175n
Dowling, J.E. fig. 17
- Formey, Jean-Henri-Samuel 81, 85,
88–91, 119, 169n, 171n
Fréart de Chambray, Roland 113,
115
Furetière, Antoine 179n
- Gautier D'Agoty, Jacques 91, 95,
172n
Ghirlandaio, Domenico 149
Gibson, James J. 160n
Gilchrist, Alan L. 63, 68–71, 163n,
fig. 24
Giotto 147, pl. xii
gnomonics 60, 85
'sGravesande, Willem Jacob 88
Gregory, Richard L. 161n, fig. 10
Grimaldi, Francesco Maria 81–84,
88, 121, fig. 25
Guericke, Otto von 116, 176n
- Hills, Paul 147
Hooke, Robert 81
Horn, Berthold K.P. 42–46, 160n,
fig. 12
- Jacob, Hildebrand 29, 158n
James, R.C. fig. 11
Jeaurat, Edme-Sébastien 84, fig. 26
Jombert, Charles-Antoine 77–79,
81, 84, 110, 115, 119, 130, 133,
153, 164–169n

INDEX

- Jurin, James 26
- Koenderink, Jan J. 56–59, 70, 146, 163n, fig. 20, fig. 21
- Lairesse, Gérard de 91–94, 171–172n, fig. 27
- Lambert, Johann Heinrich 6, 43, 88, 99–104, 119, 154, 156n, 173n, fig. 28, fig. 29, fig. 30
- Lambertian surface 6–7, 43, 59, 99, 146, 148, 161n, 173n, fig. 28
- Land, Edwin 116, 176n
- Largillierre, Nicolas 96, 104, 131, 136–139, 145, 178n, 179n, pl. viii
- Lecat, Claude-Nicolas 156n
- Lehky, Sidney R. 46–47, 160n, fig. 13
- Leibniz, Gottfried Wilhelm 20, 26
- Leonardo da Vinci 2–4, 15, 77, 103, 107, 110, 113–115, 144, 146, 151–155, 177n, fig. 2, fig. 32, fig. 37, fig. 38, pl. xv, pl. xvi
- light:
- ambient 5–6, 68–69, 74–75, 151–152
 - artificial 179n
 - conceptions of 1–2, 4–7, 80–84, 87–91, 106–107, 151–152
 - diffRACTed 2, 79–84, 86, 91, 169n, fig. 25
 - diffused 91–98, 102–103, 107–108, 153–154, fig. 27(a), and see ‘universal’
 - extended sources 5, 89, 102, 131, 152, 170n, fig. 4, pl. xvi
 - global 6, 148, and see ambient illumination
 - illumination 5–6, 38, 56–59, 68–70, 73, 131, 140–141, 146, 148, 152, 163n, 173n, fig. 3, fig. 4, fig. 11, fig. 12, fig. 24
 - location 2, 5, 15, 29, 60, 74, 99, 131, 144, 146–148, fig. 3, fig. 4, fig. 12(a),(c)
 - luminance 5, 7–11, 43, 54–59, 62–63, 70–71, 161–162n, fig. 4, fig. 12, fig. 18, fig. 19
 - point sources 86, 102, fig. 4
 - reflected 2–7, 14, 15, 18, 25, 29, 43, 63, 68–70, 77–81, 90–98, 103–111, 113, 153–154, 166–168n, 173n, 178–179n,
- fig. 3, fig. 24, fig. 27, fig. 28, fig. 31
- refracted 80–82
- terms defined 5–6
- ‘universal’ 91, 95, 96, 102, 152, 154, 155, fig. 27(a), fig. 38
- Lippi, Filippino 149, pl. xiv
- Locke, John 15, 17–20, 25–27, 56, 157n, 160n, 177n
- Mach bands 63, 68, 163n, fig. 23
- Maraldi, Giacomo Filippo 88–91, 121, 170–171n
- Mariotte, Edme 84, 169n
- Marr, David 160n, 161n, fig. 15, fig. 16, fig. 18
- Masaccio 147–148, pl. xiii
- mental imagery 39, 48–52, 71, 126, 127, 163n, and see vision: top-down
- Mérian, Jean-Bernard 25, 157n
- Millot, the abbé 29–30, 112, 116
- Mingolla, Ennio 160n
- Molyneux, William 19–22, 24–27, 36, 157n
- Monge, Gaspard 85, 170n
- Montesquieu, Charles-Louis de Secondat, baron de 28–29, 119, 158n
- Morgan, Michael J. 157n, 177n
- Newton, Isaac 80, 82, 84, 88
- Olson, Richard 160n
- Oudry, Jean-Baptiste 96, 104, 119, 121, 130–134, 136–137, 172n, fig. 33, pl. vi
- penumbra 5, 30, 82, 86, 89, 90, 102–103, 173n, fig. 30
- Piazzetta, Giovanni Battista 12–14, 15, 119, 146, 156n, fig. 5, fig. 6, pl. ii
- pictures:
- attention and 28, 29, 76–77, 127–29, 134–135, 137–138, 140, 142, 170n, 177–178n
 - drawing 12–14, 48–51, 84–85, 139–143, 149–151, 177n, fig. 26, fig. 35, pl. x
 - perception and 24–25, 34–35, 39, 48–52, 59, 76, 77, 84, 99,

- 129–130, 134–135, 136–139,
149–151, 177–178n
tonal conduct of 12–16, 32–34,
48–51, 76–77, 78–79, 84, 88–91,
104, 110, 130–133, 139–143,
146–155, 156n, 166–169n,
178–179n, fig. 27
- Piles, Roger de 76, 77, 164n, 177n,
fig. 7
- Pitteri, Marco 12–14, fig. 6
- Pollaiuolo, Antonio del 149
- Pozzo, Andrea fig. 1
- Priestley, Joseph 169n
- Ramachandran, Vilayanur S. 160n
- Raphael 28–29
- Rayleigh scattering 113, 117
- Reid, Thomas 124–125, 127–129,
177n
- Rembrandt 95, 136–138, 178n
- Rigaud, Hyacinthe 137–138, pl. vii
- rilievo 59, 146–149, 151, *and see*
shadow: shading
- Rousseau, Jean-Jacques 30–31, 119
- Rubens 178–179n
- sciography 61, 84–88, 91, 99–102,
132, 153, 169–170n, fig. 26,
fig. 30
- Sejnowski, Terrence J. 46–47, 160n,
fig. 13
- shadow:
'attached' 3–4, 77
cast 3–4, 14–15, 29–30, 60–62,
72–74, 77, 79, 84–91, 99–103,
107–108, 115–117, 121, 123,
132, 140–143, 147, 148,
152–154, 160n, 162n, 167n,
169n, 178n, fig. 22, fig. 26,
fig. 32, fig. 37, pl. xvi
- chiaroscuro/clair-obscur 16, 59,
76–77, 88, 96, 106–107, 140, 142
- colour in 78–79, 110–111, 168n
- colour of 30, 78, 81–82, 112–117,
167–168n, 173n, 178n, fig. 32
- 'derived' (in Leonardo) 152–154,
fig. 37
- edges 74–75, 82, 89–91,
102–103, 153, 162–163n, fig. 18,
fig. 25, fig. 23, fig. 34
- intensity, relative 5, 6, 15, 29, 50,
68–70, 76–78, 88, 89–91, 95, 96,
104–110, 123–124, 150,
- 153–154, 166–168n, 179n,
fig. 12, fig. 24, fig. 27, fig. 31,
fig. 34, fig. 37, fig. 38
- microshadow 6–7, 9, 32–33, 97,
125–127, 132, 139, 141–142,
163n, fig. 3
- 'original' (in Leonardo) 151–153,
fig. 37
- penumbra 5, 30, 82, 89–90,
102–103, 173n, fig. 29, fig. 30
- projected 4, 6, 7, 14–15, 32, 38,
41, 59–62, 70–74, 80, 84–91, 96,
110, 115, 123, 132–134,
139–140, 143–144, 146–148,
152–154, 161n, 169n, 173n,
179n, fig. 3, fig. 10, fig. 13,
fig. 22, fig. 26, fig. 27, fig. 29,
fig. 32, fig. 37, pl. xvi
- rilievo 59, 146–149, 151, pl. xii,
pl. xiii, pl. xiv, pl. xv, *and see*
shading
- sciography and 61, 84–88, 91,
99–102, 132, 153, 169–170n,
fig. 26, fig. 30
- self-shadow 4, 6, 7, 14, 15, 32,
36–38, 41, 42, 60, 62, 70, 88, 96,
108, 109, 123, 134, 146, 148, 149,
152–154, 178n, fig. 10, fig. 22,
fig. 27, fig. 37
- shading 4, 6, 14, 17, 32–34,
36–38, 41–47, 50, 51, 56–59, 63,
69–71, 96, 103, 128, 140,
146–149, 152–154, 160–163n,
178n, fig. 12, fig. 13, fig. 18,
fig. 20, fig. 21, fig. 24, fig. 27,
pl. xvi
- sharpness, *see* edges
- structure, internal 88–90, fig. 37
- types, perceptual fig. 34
- types, physical 2–4, 12–15
- slant/tilt 4, 7, 36, 41–43, 125, 134,
146, 153
- specular surface 7, 33, 75, 131, 133,
141, 146
- Subleyras, Pierre 32–35, 119, 159n,
pl. i
- Tiepolo, Giovanni Battista 48–50,
119, 161n, fig. 14, pl. iii
- Todd, James T. 160n
- Todes, Samuel 179n
- touch, sense of 19–22, 24, 26–28,
124, 125

- Van Doorn, Andrea J. 56–59, 70, 71, 73, 146, 163n, fig. 20, fig. 21
Verrocchio, Andrea del 149, 151
Vinci, Leonardo da, *see* Leonardo da Vinci
vision:
bottom-up 35, 48, 52, 63
constancy in 116–117, 125
contrast and 7, 51, 63, 68–69, 91, 109, 115–116, 148, 153, 163n, 166n, 167n, 169n, fig. 23
empiricist theories of 17–28
eye and 1–2, 5–8, 38, 52–56, 53, 71, 78, 124, 150–151, fig. 17
luminance discontinuities 8, 35, 56, 70, 161n, 162n
machine 36, 42–47, 55–56,
59–67, 149–150, 159–162n
nativist theories of 17, 20
parallel processing 46–47, 56, 59, 71, 128, 160n, fig. 13
serial processing 44–46, 56, 128, 129, 160n, 162n, fig. 12
spatial frequency 55, 150, 163n, fig. 18, fig. 19
top-down 35, 39–41, 48, 50, 52, 63, 72, fig. 17
Voltaire, François-Marie Arouet 25
Waltz, David 61–66, 70, 71, 163n, fig. 22
Watt, Roger fig. 4, fig. 19
Yonas, Albert 160n