

Neurocultural Health and Wellbeing

Series Editors: L. Lorusso · B. Colombo · A. Porro · N. Wade

Amy lone

Neuroscience and Art

The Neurocultural Landscape

 Springer

Neurocultural Health and Wellbeing

Series Editors

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Aim of this devoted book Series in neurology is to highlight the relationship between neuroscience and culture. Nowadays, there is more evidence of how our brain is influenced by the various artistic and cultural disciplines, both in the form of entertainment as well as – and above all – through the emotions and gratification which lead to wellbeing. The emotional mechanisms, the different cultural manifestations provided, are due to the activation of a perceptual and cognitive range that constitute the basis of the social behaviors. All this makes us aware of the benefits the arts have on personal and collective health.

This concept was already known to philosophers in ancient times, who were convinced that inner balance was influenced by culture and in particular by music.

During the centuries, men understood that the *cultivation of the spirit*, or *humanitas*, had a certain role on behavior and from the beginning of modern experimental science, in the fifteenth, the spread of the notions of neuroanatomy allowed artists to get closer to the knowledge of the brain's mechanisms and reveal the emotional and empathic responses at the basis of creativity, and indeed of their own psychophysical wellbeing. A dialogue between the science of the mind and artistic disciplines was born. The results of this meeting made it possible to better define which mental processes are involved when we come into contact with the various humanistic disciplines, and how they can be applied, for instance, to the treatment of mental disorders and neuropsychiatric diseases.

The goal of this Series is both to prove the role of biological brain mechanisms and the influence of various artistic forms on clinical practice, especially in neuropsychiatric disorders, as well as to trace different therapeutic and psycho-physical well-being applications based on scientific evidence from medical literature.

Volumes of the Series will be edited by experts under the supervision of an international editorial committee. Each book, focused on a specific discipline, will provide knowledge on relationship between the brain activity and different forms of language, communication, art. This close inter-relationship with specific focus on different forms of art will explain the effectiveness of this kind of approaches in neuro-psychiatric diseases.

This Series will allow to understand how the culture is one of the fundamental tools to improve general well-being, quality of life and motivation in neurological diseases.

This Series also find a correlation with SDG3 goal “ensuring healthy lives and promoting wellbeing for all at all ages” for the progress of the health and wellbeing considering that neurological diseases are on the rise worldwide including in the developing countries.

Amy lone

Neuroscience and Art

The Neurocultural Landscape

 Springer

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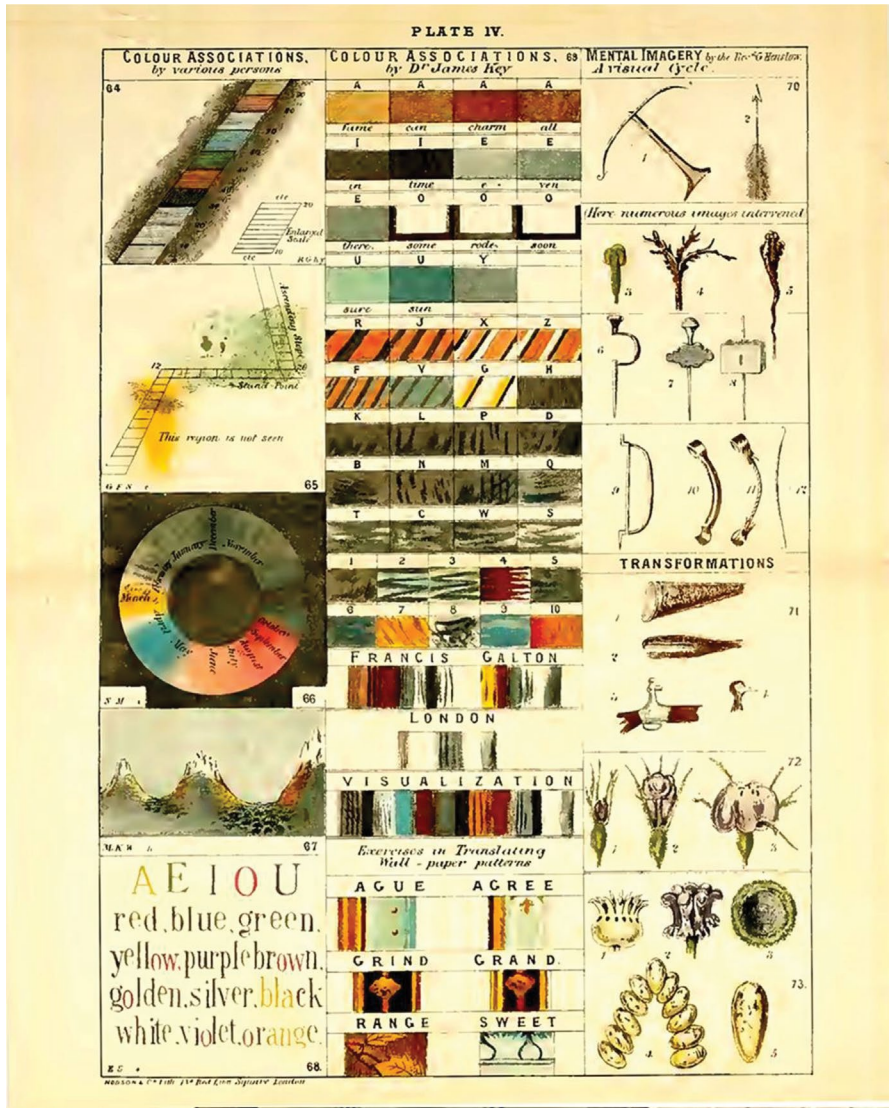


Plate IV from Francis Galton's *Inquiries into Human Faculty and Its Development* (1883). This compilation is an abridged summary of Galton observations on mental imagery. This book brought what we now call synesthesia to the attention of the scientific community

*In Memory of Dame [Jean] Iris Murdoch
(1919–1999) whose thought-provoking book
The Fire and the Sun: Why Plato Banished
the Artists first motivated me to think about
the complexity of art and culture many
years ago.*

And

*For Christopher Tyler, whose stimulating
mind encompasses both an expertise in
neuroscience and a knowledge of art that has
become an intrinsic part of this book's
texture.*

Preface

Understanding ourselves as humans is incomplete without considering both biological and cultural aspects. In this book, the neurocultural perspective reflects how everything in the world is filtered back and forth between the brain and the cultural milieu. The thrust of the book, therefore, is to explore the power of art in creating a bridge between cultural and neuroscientific lines of inquiry. Looking at both clinical and non-clinical populations, the text examines historical foundations, distinguishes congenital/developmental conditions from those that are acquired, and emphasizes how the brain constructs our sensory experiences. Topics include the value of case studies, film, war's impact on medicine and art, therapeutics, and education. A range of conditions are integrated, such as prosopagnosia, synesthesia, autism, Alzheimer's disease, and so forth. Artists from all genres are incorporated. Among them are Iris Murdoch, Ludwig van Beethoven, Leonardo da Vinci, Cristoforo de Predis, Rembrandt, Federico Fellini, Chuck Close, and David Hockney. This book will be of interest to a broad range of clinicians and neuroscientists as well as those in the arts and humanities in general.

Berkeley, CA, USA

Amy Ione

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Contents

Part I Overview

1	Historical Neuroculture	3
1.1	Why a Neurocultural Perspective?	3
1.2	Why History Matters	5
1.3	Egypt	6
1.4	The Ancient Greeks and Etymology	9
1.5	The Functional, the Neuroatypical, and the Senses	13
1.6	Greek Art and Aesthetics	15
1.7	Art and Anatomy	17
1.8	Leonardo da Vinci: Anatomical Studies	24
1.9	Leonardo da Vinci: Expressive Studies and Deaf Painters	26
1.10	Andreas Vesalius and Medical Dissection	28
1.11	Theory and Applications	28
	References	31
2	Early Experimentation, Theories, and Applications	35
2.1	Experimental Neurology, Philosophy of Mind, and the Seventeenth Century	35
2.2	Language: Aphasia and Sign Language	41
2.3	Vision and Brain Function	44
2.4	Physiology, Sensation, Perception	47
	References	52
3	Biological and Genetic Perspectives	55
3.1	Autism	56
3.2	Savant Syndrome	60
3.3	Temple Grandin	62
3.4	Down Syndrome	63
3.5	Art History and Down Syndrome	65
3.6	Judith Scott: Fiber Artist	67
3.7	The Carlin Brothers	72
	References	75

4 Social and Environmental Modifications: Dynamics of Change 79

4.1 Hearing Loss: Ludwig van Beethoven 79

4.2 Maurice Ravel: Aphasia, Apraxia, Agraphia, Amusia 85

4.3 Paul Wittgenstein: Phantom Movements 87

4.4 Performing Art and the Deaf 89

4.5 Visual Art: Stroke 91

4.6 Kurt Schwitters 93

4.7 Color-Blindness: Historical Notes 94

4.8 Achromatopsia: Color-Blindness 95

4.9 The Color-Blind Painter: Jonathan Isaacson 97

4.10 Conclusion 99

References 99

Part II Case Studies

5 A Luminous Presence: Iris Murdoch 105

5.1 Dame (Jean) Iris Murdoch 106

5.2 Studies of Iris Murdoch’s Brain 109

5.3 Iris Murdoch on Film 111

5.4 Iris Murdoch on Art 113

5.5 What Is Art? 115

5.6 Conclusion 117

References 118

6 Biography and Biology: Oliver Sacks 121

6.1 Beginnings: What Is It To Be Human? 123

6.2 Case Studies: Seeing People As More Than Pathologies 124

6.3 Writings and Derivatives 126

6.4 *Migraine: The Evolution of a Common Disorder* (1970) 127

6.5 *Awakenings* (1973): Encephalitis Lethargica 130

6.6 *Awakenings* Derivatives 135

6.7 *A Leg to Stand On* (1984): Disturbance of Proprioception 136

6.8 *The Man Who Mistook His Wife for a Hat* (1985) 139

6.9 Peter Brook: *The Man Who* 141

References 143

7 Neuroculture and Image Technology 145

7.1 The Magic Lantern 147

7.2 Nineteenth Century Magic Lantern and Photographic
Therapeutics 150

7.3 Photography and Film 153

7.4 Actualities 157

7.5 Film Technique and Syntax 163

7.6 Intertitles 165

7.7 Mirror Neurons and Empathy 166

7.8	Case Studies	167
7.8.1	Buster Keaton: “The Boy Who Can’t Be Damaged”	168
7.8.2	Ingmar Bergman (1918–2007): <i>Persona</i> (1966)	171
7.8.3	Luchino Visconti (1906–1976) and Federico Fellini (1920–1993).	173
7.8.4	Anterograde Memory Impairment	174
7.9	Conclusion	175
	References.	176
8	War and Art: Brain Injuries, Trauma, and Empathy	181
8.1	World War I (The Great War).	182
8.2	Phantom Limbs	187
8.3	Film: Research and German Expressionism	189
8.4	Biography, Identity, Literature, and Culture	190
8.5	Pablo Picasso and <i>Guernica</i> (1937).	191
8.6	German-American Film Director William Wyler	194
8.7	American Film Director John Huston	196
8.8	Post-traumatic Stress Disorder (PTSD).	197
8.9	Shell Shock Revisited	199
8.10	Conclusion	200
	References.	201
9	Neurocultural Therapeutics and Applications	205
9.1	Therapeutic Approaches and Strategies	206
9.2	Novelist Howard Engel: The Writer Who Could Not Read.	214
9.3	Related Alexia Cases	218
9.4	Therapeutic Outreach: Centers and Programs	219
9.5	Deaf Culture and Therapeutic Controversies.	222
9.6	Conclusion	224
	References.	224
Part III The Neurocultural in Practice		
10	Translation and Education	231
10.1	Jean-Dominique Bauby: The Diving Bell and the Butterfly	232
10.2	Locked-in Syndrome	234
10.3	Painting: A Translation Tool After Brain Injury	236
10.4	Translation and Adaptation: Stereopsis and Strabismus	237
10.5	Historical Strabismus	238
10.6	Translation and Education: Academic Projects	242
10.7	Temple Grandin Revisited	244
10.8	Conclusion	245
	References.	247
11	Faces and Face Blindness (Prosopagnosia).	249
11.1	A Brief Chronology of Faces and Face Blindness.	249
11.2	The Complexity of Face Blindness/Prosopagnosia	259

11.3	Congenital Prosopagnosia and Art.	262
11.4	Chuck Close: Portrait Painting with Prosopagnosia	263
11.5	David Hockney: Portrait Painting Without Prosopagnosia	267
11.6	Conclusion	269
	References.	269
12	Synesthesia and the Senses	273
12.1	Synesthesia’s Definitional Elasticity	275
12.2	Synesthesia in History	280
12.3	Early Scientific Investigations of Synesthesia	285
12.4	Art and Synesthesia	293
12.5	Syntax: Color Organs.	294
12.6	Syntax: Klüver Constants	297
12.7	Testing and Verification	298
12.8	Syntax, Synesthesia, Metaphor, and Multisensory Experiences . . .	300
12.9	The Larger Picture	301
12.10	Conclusion	304
	References.	305
	Appendix A: The Mute’s Lament by John Carlin	311
	Appendix B: Dulce et Decorum Est by Wilfred Owen	313
	Index.	315

About the Author

Amy Ione is the Director of The Diatropé Institute, an organization for the dissemination of interdisciplinary information. She is a writer, artist, and educator and has studied the extensive linkages between art and neuroscience for over 30 years. She has published several books, including *Innovation and Visualization: Trajectories, Strategies, and Myths*; *Art and the Brain: Plasticity, Embodiment, and the Unclosed Circle*; and *Nature Exposed to Our Methods of Questioning*. *Neuroscience and Art: The Neurocultural Landscape* is her sixth book. Amy had also published over 200 articles and book reviews on art, neuroscience, technology, and cultural issues. In addition, Amy Ione is a lifelong artist, with artwork commissioned by the City of San Francisco, exhibited internationally, and found in many collections.

List of Figures

Fig. 1.1 A mural of a blind musician playing a harp, from the tomb of the ancient Egyptian scribe called Nakht. c. 1422–1411 BCE. Courtesy of the Yorck Project. 8

Fig. 1.2 The four qualities, elements, humors, and temperaments. Drawing, 19—. Courtesy of the Wellcome Collection 12

Fig. 1.3 A physician bleeding a patient, other patients are waiting to see him. Gouache painting. After a painting on a Greek aryballos, ca. 480–460 BCE. Courtesy of the Wellcome Collection. 17

Fig. 1.4 Frontispiece of Mondino de Liuzzi’s *Anathomia corporis humani* (1316). The original edition of his book carried no illustrations but was later visually updated by followers of de Liuzzi, including the anatomist Berengario da Carpi (1466–1530) and the German anatomist Johannes Dryander in 1541 18

Fig. 1.5 *Battle of the Nude Men*. Artist: Antonio Pollaiuolo (Italian, Florence ca. 1432–1498 Rome). Date: ca. 1470–90. Engraving. Sheet: 15 1/8 × 23 3/16 in. (38.4 × 58.9 cm). Courtesy of the New York Metropolitan Museum Art, Joseph Pulitzer Bequest, 1917 19

Fig. 1.6 Studies for the Libyan Sibyl (recto); Studies for the Libyan Sibyl and a small Sketch for a Seated Figure (verso). Artist: Michelangelo Buonarroti (Italian, Caprese 1475–1564 Rome). Date: ca. 1510–11. Medium: Red chalk, with small accents of white chalk on the left shoulder of the figure in the main study (recto); soft black chalk, or less probably charcoal (verso). Dimensions: Sheet: 11 3/8 × 8 7/16 in. (28.9 × 21.4 cm). Courtesy of the New York Metropolitan Museum of Art, Purchase, Joseph Pulitzer Bequest, 1924 21

Fig. 1.7 Andreas Vesalius (1514–1564). *De humani corporis fabrica* (1543), The brain, in right profile with the glossopharyngeal and vagus nerve and, to the right, a view of the base of the brain. Photolithograph, 1940, after a

woodcut, 1543. Wellcome Collection. Public Domain
 Mark. Courtesy of the Wellcome Collection 23

Fig. 2.1 Circle of Willis by Christopher Wren for Thomas Willis’
Cerebri Anatome. Courtesy of the Wellcome Collection. 37

Fig. 2.2 *Philocophus: or, The deafe and dumbe mans friend*
 (frontispiece). This frontispiece depicts reactions to the
 vibrations produced by musical instruments and includes a
 deaf man listening to music by bone conduction through
 the teeth (on the lower left), biting the end of a viola de
 gamba. Figure 2.3 shows a detail of the deaf man listening
 on the lower left. Courtesy of the Folger Shakespeare Library 40

Fig. 2.3 *Philocophus: or, The deafe and dumbe mans friend*
 (frontispiece detail). This frontispiece depicts reactions to
 the vibrations produced by musical instruments and this
 detail shows the deaf man listening to music by bone
 conduction through the teeth, biting the end of a viola de
 gamba. Figure 2.2 shows the full image. Courtesy Folger
 Shakespeare Library. 41

Fig. 2.4 Tobias Curing His Father’s Blindness. Artist: Bernardo
 Strozzi. Oil on canvas. 57.5x88” (146.1x223.5 cm). Date:
 1630–35. Courtesy of the New York Metropolitan
 Museum of Art. Purchase, Mary Wetmore Shively
 Bequest, in memory of her husband,
 Henry L. Shively, M.D., 1957 45

Fig. 2.5 Hermann von Helmholtz. Figure 17 in *Handbuch der*
physiologischen Optik, Volume 1. Note that the inferior
 rectus and inferior oblique are not visible in the figure: the
 superior rectus is removed from the right eyeball in order
 to show the optic nerve “N” 49

Fig. 3.1 Down syndrome human karyotype 47, XY, +21. Wessex
 Reg. Genetics Centre. Attribution 4.0 International (CC
 BY 4.0). Courtesy of the Wellcome Collection 64

Fig. 3.2 *The Adoration of the Christ Child*. Follower of Jan Joest of
 Kalkar (Netherlandish, active ca. 1515). Oil on wood.
 Overall measurement: 41 × 28 1/4 in. (104.1 × 71.8 cm);
 painted surface 41 × 27 5/8 in. (104.1 × 70.2 cm).
 Courtesy of the New York Metropolitan Museum of Art,
 The Jack and Belle Linsky Collection, 1982 66

Fig. 3.3 Detail: *The Adoration of the Christ Child*. Follower of Jan
 Joest of Kalkar (Netherlandish, active ca. 1515). Oil on
 wood. Overall measurement: 41 × 28 1/4 in.
 (104.1 × 71.8 cm); painted surface 41 × 27 5/8 in.
 (104.1 × 70.2 cm). Courtesy of the New York
 Metropolitan Museum of Art, The Jack and Belle Linsky
 Collection, 1982. 67

Fig. 3.4	Book cover: <i>Entwined: Sisters and Secrets in the Silent World of Artist Judith Scott</i> by Joyce Scott. Courtesy of Beacon Press	68
Fig. 3.5	<i>After a Long Cruise</i> . Artist: John Carlin (American, Philadelphia, Pennsylvania 1813–1891 New York), 1857. Medium: Oil on canvas. 20 × 30 in. (50.8 × 76.2 cm). Courtesy of the New York Metropolitan Museum of Art, Maria DeWitt Jesup Fund, 1949	73
Fig. 3.6	Sketch from John Carlin’s 1835–56 account book ledger. Ink on paper. Dimensions: 7 1/2 × 6 1/4 in. (19.1 × 15.9 cm). Courtesy of the New York Metropolitan Museum of Art, Dale T. Johnson Fund, 2009	73
Fig. 4.1	Ludwig Van Beethoven. Artist: Henry Ulke, 1875. Oil on canvas, 26 1/4 × 21 1/4 in. (66.7 × 54.0 cm.), Courtesy of the Smithsonian American Art Museum, Gift of Titus Ulke, 1998.44	80
Fig. 5.1	An MRI brain scan performed on Iris Murdoch’s brain in June 1997. Sample T1-weighted images from I.M.’s MRI (left hemisphere on right) showing bilateral hippocampal atrophy, moderate to severe global volume loss, with a temporal and parietal predominance. From <i>Brain</i> , Volume 128, Issue 2, February 2005, pages 250–260, https://doi.org/10.1093/brain/awh341	110
Fig. 6.1	Peter Brook and Carol Steen talking about synesthesia and hypnagogia above Peter’s theatre Bouffe du Nord, Paris. July 13, 2019. Photograph courtesy of Carter Jones	142
Fig. 7.1	An illustration of the Allegory of the Cave, from Plato’s <i>Republic</i> . This file is licensed under the Creative Commons Attribution-Share Alike 4.0 International license	146
Fig. 7.2	Jan van Musschenbroek’s magic lantern in Gulielmo Jacobo Gravesande’s 1720 book <i>Physices Elementa Mathematica</i>	148
Fig. 7.3	Nineteenth century magic lantern. Andrei Niemimäki, CC BY-SA 2.0 < https://creativecommons.org/licenses/by-sa/2.0 >, via Wikimedia Commons	149
Fig. 7.4	<i>The Magic Lantern</i> . Artist: Auguste Edouart (French; 1789–1861); Date: ca. 1835; Medium: Cut paper and wash; Dimensions: image: 9 1/2 × 13 3/8 in. (24.2 × 33.9 cm); sheet: 10 1/4 × 13 1/2 in. (26 × 34.3 cm). Courtesy of the New York Metropolitan Museum of Art, Bequest of Mary Martin; 1938; Accession Number: 38.145.392.	150
Fig. 7.5	Stereogram of the New Pennsylvania Hospital for the Insane building (Langenheim Collection). Courtesy of the Library Company of Philadelphia	152

Fig. 7.6	<i>Attaque de Sommeil Hysterique</i> . Albert Londe, <i>La Photographie Médicale: Application aux Sciences Médicales et Physiologiques</i> , Paris 1893, Plate VIII. Courtesy of the Wellcome Collection	152
Fig. 7.7	Plate from <i>Animal locomotion: an electro-photographic investigation of consecutive phases of animal movements</i> . A girl with multiple cerebral-spinal sclerosis walking with a nurse. Collotype after Eadweard Muybridge, 1887. Courtesy of the Wellcome Collection	155
Fig. 7.8	<i>Fred Ott's Sneeze</i> . Edison kinetoscopic record of a sneeze/ taken and copyrighted by W. K. L. Dickson, Orange, N.J. Courtesy of the Library of Congress	159
Fig. 7.9	Pierre-Auguste Renoir filmed painting at home (1915). Filmed by Sacha Guitry. Courtesy of JRH Films.	159
Fig. 7.10	<i>Two Young Girls at the Piano</i> . Auguste Renoir. 1892. Oil on canvas. 44 × 34 in. (111.8 × 86.4 cm). Courtesy of the New York Metropolitan Museum of Art. Robert Lehman Collection, 1975.	160
Fig. 7.11	<i>Tilla Durieux</i> (Otilie Godeffroy, 1880–1971). Auguste Renoir. 1914. Oil on canvas. 36 1/4 × 29 in. (92.1 × 73.7 cm). Courtesy of the New York Metropolitan Museum of Art, Bequest of Stephen C. Clark, 1960	161
Fig. 7.12	Still shots from <i>The General</i> , a 1926 American silent film released by United Artists. The film stars Buster Keaton, who co-directed it with Clyde Bruckman	164
Fig. 7.13	Still shots from a case study of multiple personality, recorded in 1923 by C. C. Wholey and Edward J. Carroll.	165
Fig. 7.14	Screen shot from <i>Sherlock Jr.</i> , a 1924 American silent comedy film directed by and starring Buster Keaton.	169
Fig. 8.1	W.H.R. Rivers and Sir Henry Head experimenting on nerve function. Courtesy of the Wellcome Collection	186
Fig. 8.2	<i>A human experiment in nerve division</i> . W.H.R. Rivers and Henry Head. 1908. <i>Brain</i> 1908: 31; 323–450. To show the extent of the loss of sensation 50 days after the operation (June 14, 1903). The dark black line encloses the loss to cutaneous tactile stimuli; the lighter line encloses the cutaneous analgesia. Wherever these lines are broken, the border was an indefinite one. Courtesy of Oxford University Press	200
Fig. 9.1	David Playing the Harp Before Saul, ca. 1508. Artist: Lucas van Leyden (Netherlandish, Leiden ca. 1494–1533 Leiden). Engraving; first state. Sheet: 10 × 7 1/4 in. (25.4 × 18.4 cm). Courtesy of the New York Metropolitan Museum of Art, Rogers Fund, 1918.	207

- Fig. 9.2 Art therapy in St. Elizabeths Hospital. Dr. John Lind displays the handiwork of one of his patients entitled “dimensional divertissement.” Courtesy of the National Library of Medicine 209
- Fig. 9.3 William James (1842–1910). Photographer: William Notman. Courtesy of the National Library of Medicine 210
- Fig. 9.4 Jean-Martin Charcot demonstrating hysteria in a hypnotized patient at the Salpêtrière. Etching by A. Lurat, 1888, after P.A.A. Brouillet, 1887. Courtesy of the Wellcome Collection 213
- Fig. 10.1 Giovanni Francesco Barbieri, called Guercino. 1623. Artist: Ottavio Leoni. Engraving. National Gallery of Victoria, Melbourne. Everard Studley Miller Bequest, 1959. Courtesy of the NGV Collection Online through the generous support of the Joe White Bequest 240
- Fig. 10.2 Rembrandt: Self-Portrait. Artist: Rembrandt (Rembrandt van Rijn) (Dutch, Leiden 1606–1669 Amsterdam). Date: 1660. Medium: Oil on canvas. Dimensions: 31 5/8 × 26 1/2 in. (80.3 × 67.3 cm). Courtesy of the New York Metropolitan Museum of Art, Bequest of Benjamin Altman, 1913 241
- Fig. 11.1 Portrait of a Youth with a Surgical Cut in One Eye. Roman Period (Egypt), 190–210 CE. Medium: encaustic on limewood. Dimensions: H. 35 × W. 17.2 cm (13 3/4 × 6 3/4 in.). Courtesy of The Metropolitan Museum of Art, Rogers Fund, 1909. 250
- Fig. 11.2 Rembrandt: Self-Portrait (reworked by another hand). Artist: Rembrandt (Rembrandt van Rijn) (Dutch, Leiden 1606–1669 Amsterdam). Date: 1635–1640. Medium: Pen and brown ink, brush and brown and gray ink, brown and gray washes. Dimensions: 5 3/8 × 4 1/2 in. (13.6 × 11.4 cm). Courtesy of the New York Metropolitan Museum of Art, Robert Lehman Collection, 1975. 251
- Fig. 11.3 Gall’s physiological map. Plate from *Anatomie et physiologie du système nerveux en général, et du cerveau en particulier, avec des observations sur la possibilité de reconnoître plusieurs dispositions intellectuelles et morales de l’homme et des animaux par la configuration de leurs têtes*/Par F. J. Gall et G. Spurzheim. Courtesy of the Wellcome Collection 252
- Fig. 12.1 Two synesthetic colored alphabets. Patricia Lynne Duffy’s alphabet is on the left and Carol Steen’s alphabet is on the right. Published in *Blue Cats and Chartreuse Kittens* by Patricia Lynne Duffy. Painted by Carol Steen. Courtesy of Patricia Lynne Duffy and Carol Steen 276

Fig. 12.2 Geometric diagrams of spatial sequence synesthesia published by *Science Magazine* in 1883. C. Ruheit (right) shows how he perceives the months and important dates. Arthur Winslow’s conception of the month and his number diagram are shown on the left. 276

Fig. 12.3 “Runs off in Gold,” 2003. Artist: Carol Steen. Courtesy of the artist 278

Fig. 12.4 Blue Hypnagogic Mandala, 2014. Artist: Carol Steen. Courtesy of the artist 279

Fig. 12.5 Plate IV from Francis Galton’s *Inquiries into Human Faculty and Its Development* (1883). This compilation is an abridged summary of Galton observations on mental imagery. This book brought what we now call synesthesia to the attention of the scientific community. 287

Fig. 12.6 Engraving of the D.A. number forms derived from patient diagrams for Francis Galton. Published in *Inquiries into Human Faculty and Its Development* in 1883 288

Fig. 12.7 Number forms of Francis Galton’s patient T. M. Published in *Inquiries into Human Faculty and Its Development* in 1883 288

Fig. 12.8 Frederick Starr (1858–1933) on “Note on Color-Hearing” (pseudo-chromesthesia), 1893 290

Fig. 12.9 A caricature of Louis Bertrand Castel’s “ocular organ” by Charles Germain de Saint Aubin. Waddesdon, The Rothschild Collection (The National Trust). 295

Fig. 12.10 This image demonstrates the automaticity of synesthetic experience. A synesthete might perceive the left panel like the panel on the right. This image first appeared in Ramachandran, V.S., Hubbard, E.M.: Synaesthesia: A window into perception, thought and language. *Journal of Consciousness Studies* 8, 3–34, 2001, Fig. 12.1. The authors and the journal have granted permission for use under the terms of the GNU Free Documentation License 299

Fig. 12.11 *Carnival in the Snow*. Paul Klee, 1923. Drawing sheet: 24 × 23.5 cm (9 7/16 × 9 1/4 in). In this watercolor, acrobats and circus jugglers emerge from a complex pattern of shapes and colors. Published in collaboration with the Cleveland Museum of Art and their Open Access initiative 302

Part I
Overview



1.1 Why a Neurocultural Perspective?

Why write a book about neuroscience and art from a neurocultural perspective? The obvious reason is that understanding who we are as humans is incomplete without considering the interplay between biological and cultural perspectives, or neuroculture. Neuroculture in this book is addressed along the lines mentioned by Oliver Sacks when explaining his approach to neurology. From childhood he gravitated to medicine in part because he learned to see it as the study of stories of people. Each evening at the dinner table his physician parents talked about the patients they had seen during their day. This interest in the patient as an individual followed him to medical school and eventually led him to share the stories of lives impacted by disease or injury, conveying the uniqueness of each person in the process [1].

Neuroculture includes this comprehensive view of human health and well-being as seen through the profile of each individual. On the following pages, this spectrum is examined through neuroscientific research and a range of art forms that demonstrate the value of the arts. The arts are adept in communicating our joys and sorrows. They may tell a personal story or show declining health. They also record family interactions, social matters, and the indescribable. Syntax varies among the arts, just as intentions in making art do. Indeed, art may be expressive, therapeutic, challenging, uplifting, or defy characterization. Because the production, enjoyment, and value of art includes more than “art as beauty,” we all benefit from comprehensively acknowledging the degree to which art and the brain interactions encompass all aspects of the complex human experience.

In his book *Musicophilia* [1], Oliver Sacks spoke to this point from another perspective when he noted that music was always one of the first things he looked up in any new neurology or physiology textbook. He adds that he developed this habit because he could scarcely find any mention of the subject until the 1977 publication of *Music and the Brain* [2] edited by Macdonald Critchley and R. A. Henson. Sacks hypothesized that one reason for the earlier scarcity of musical case histories was

that physicians rarely ask their patients about mishaps of musical perception whereas linguistic problems immediately come to light [1]. This chapter explores the history behind this lacuna, as does the next chapter on experiment, theory, and applications.

Music and the Brain [2] documented a symposium Critchley and Henson assembled in 1972. In their introduction to the proceedings they note that participants, to their surprise, realized that this event was the first occasion the subject of music and the brain had been submitted to serious discussion by neurologists, although the sedative and even therapeutic effects of music had been referred to on and off since the pre-Homeric myth of Orpheus and Eurydice [2]. Elaborating on this historical vacuum, Henson acknowledges that musicians in effect filled the gap as they pursued and perfected their craft:

There is a wealth of distinguished writing by neurologists on philosophical and literary matters, and music has fared ill by comparison.... Even Henry Head limited his work on music to observations on the effects of brain damage on musical functions, although he had a good knowledge of music and the intellect and imagination to make a major contribution.... musicians have rightly made their own studies in practical or applied neurology. Teachers have expounded their ideas on motor activity and voice production as they relate to performance, hitherto with little assistance from neurophysiologists. Others have recorded their views on memory, an area where neurological knowledge is enlarging and increasingly capable of helping the musician (p. 3, [3]).

Recent historiographical work has begun to fill this gap with coverage of a wide array of topics, controversies, and competing perspectives [4–9]. Therefore, at this time there are many resources for those who wish to go beyond the historical summary offered here.¹ In examining this topic neuroculturally, this chapter and the next demonstrate how our understanding of brain function, sensory input evaluation, and higher-order functions has changed over the course of time. For example, looking at older material allows us to identify assumptions that became implicit and how they were initially interwoven into the cultural fabric before they were superseded as new knowledge emerged. This kind of comparative analysis also allows us to better comprehend current understandings of brain functions, brain injury, sensory modalities, brain plasticity, and the brain/culture exchange. A key variable, often underemphasized, is that it was not always understood that the brain constructs our experience. In other words, even with less understanding than the limited understanding we have today about neuroscience and the arts, people understood that the body, the mind, the brain, and culture are connected. So, on an experiential level, it was known that listening to music, for example, is not just auditory or emotional, it is motoric as well—and adds to human experience.

Before I turn to this historical material, let me note that art in this volume is not defined as Fine Art or an aesthetic that operates on some kind of lofty plane. Rather,

¹ In earlier work I have offered detailed historical chronologies on intersections between art and the brain, including collaborative work between artists and medical practitioners that aided research projects (see [10–17]). I have also examined art in relation to the history of psychology, the mind, and the brain elsewhere (see [12, 18]).

art covers a spectrum. It is a form of communication; a tool used to foster health and well-being; a therapeutic tool; a creative and innovative approach to problem-solving or expression; and it is an array of language forms, for each medium uses its own syntax. It is static, like painting and sculpture. It is dynamic, like music and the performing arts. It is found in both popular culture and more refined venues.

Finally, a few words about the book's overall organization. The four chapters that comprise Part I offer an overview that sets the tone for the book. Chapters 1 and 2 introduce historical assumptions and distinguish them from our contemporary knowledge base. Chapters 3 and 4 take this further, distinguishing biological and genetic conditions from those acquired later life. Together these two chapters stress that although an acquired condition is clearly biological and possibly related to genetics or environmental factors, it often creates a rupture that distinguishes it from a condition one knows from birth and infancy. In other words, baseline matters.

Part II presents a series of individual and thematic case studies. It opens with two chapters that contrast the work and conditions of two storytellers, Iris Murdoch and Oliver Sacks. Murdoch, a novelist/philosopher and a cultural icon, invented stories. Sacks, a neurologist, introduced the narratives of his patients to a larger public. Their health challenges and derivatives further frame each in terms of their inspirations, aspirations, and accomplishments. The case studies presented in Chapters 7, 8, and 9 offer thematic neurocultural examinations. Topics include technology, war, and therapeutics. The closing chapters that comprise Part III focus in on practices. The thrust encompasses both how individuals learn about and/or translate specific neuroatypical conditions and also covers how novices, specialists, and the atypical differ.

1.2 Why History Matters

History shows that seeking to comprehend life's complexity biologically and culturally has long roots. People have always asked who am I, what is nature, and how do we best live together? The "answers" have touched on ways of healing the ill, how to teach social mores to the community, and the development of communication tools such as language, art, music, and the performing arts. Within this, the loss of biological function and the preservation of well-being were always of great concern—and loss was interpreted as something that needed understanding, compassion, and cure to the degree possible. Thus, throughout time people have responded to health challenges, body changes, and mishaps by investigating the onset of illness or injury; just as they have found ways to enhance sensory experience and community.

We can identify investigations across the globe, even rudimentary work in ancient times, that included studies of the how the body works, surgeries to heal it, and pharmacological methods that were developed from the testing of crude extracts of plants, animals, and minerals for their medicinal properties [4, 6, 9, 19]. We can also identify experimentation and discussion regarding healthy living and education. We additionally find that in earlier times the neuroatypical and those with congenital

anomalies had fewer developmental prospects than those with acquired conditions, a point expanded on throughout this volume.

Art, too, was a part of the human equation. This is shown by a recent discovery of prehistoric bone and ivory flutes from the early Aurignacian period of southwestern Germany. These instruments affirm there was a musical tradition when modern humans colonized Europe, more than 35,000 calendar years ago [20]. Painting, like music, is found historically, as the known Cave Art throughout the world and extending back 40,000 years reminds us. Singing, a musical behavior that leaves no physical trace behind is no doubt a part of this history too for we see it depicted in ancient visual artwork. And surely the universality of beat perception would have given people the urge to move when their instruments were played, even among those listeners who were only minimally musical.

Although non-western lines of thought are largely outside the scope of this study, some are mentioned briefly in this chapter to underscore that not only were physiological functions and healing methodologies debated within cultures, but we can recognize them across cultures as well.² What I want to first stress here is that interpreting the earliest known cultural paradigms is challenging for us today due to the difficulty in separating magic and religion from clinical and experimental science in the documents and artifacts. Source materials that have survived do nonetheless offer a wide range of clues.

1.3 Egypt

In Egypt we can find evidence of sophisticated efforts to understand neurological conditions recorded in the *Edwin Smith Surgical Papyrus* and the *Ebers Papyrus* [6, 24]. These date from about 1500–1700 BCE, with the *Smith Papyrus* considered the older of the two. Several of the cases discuss the brain, meninges (coverings of the brain), spinal cord, and cerebrospinal fluid. Some include head injuries. From their descriptions we can see that the Egyptian physicians were aware that symptoms of central nervous system injuries could be felt far from the locus of damage [4, 6]. We also find sensory discussions. For example, in the *Ebers Papyrus* we find the earliest mention of deafness and otology on the list of medical remedies and spells against common ailments, which includes “the ear that hears badly.” This suggests a loss of hearing rather than congenital deafness. The Egyptian notations about acquired deafness are also worth noting because congenital conditions were considered more puzzling than acquired ones,³ as was the case in many cultures of the time.

²There is a growing body of work that looks comparatively and/or at other cultures (see [19, 21–23]). This interdisciplinary approach is important because it emphasizes the need for understanding human populations on both biological and cultural terms.

³Throughout this book deafness and loss of hearing are frequent topics. Therefore, it is important to note that people belonging to the Deaf Community do not consider deafness to be a disability and embrace the values upheld by the cultural model of Deafness [25].

Cited among the recorded observations we also find many eye problems even as far back as the *Ebers Papyrus*, again reinforcing that the Egyptians were keen observers. But, here too, there is no sense that they associated the retina with the optic nerve, for instance (see Fig. 2.5). Their documents do affirm they could, and did, observe the loss of visual perception and obvious biological degeneration or injury. Notations like a white opacity in the cornea of the eye show they could likewise identify physical symptoms of ailments such as leucoma, cataracts, and glaucoma. This is also evident from the cataloged treatments for eye diseases, although in many cases, the treatments themselves appear questionable (like using urine as an eyewash) [4].

The documentation makes it clear that ancient physicians were good observers but did not have enough information to consider healing and diagnostic options to the degree possible today. Obviously, they lacked the kinds of imaging tools we now have that allow us to see through opaque bodies and view brain processes. They also lacked any quantitative sense of electrophysiology, biochemistry, and the kinds of data we are beginning to accumulate on genetics, mutations, and the impact of environmental factors. Still, congenital abnormalities and “freaks” were catalogued, giving the impression that they saw this as a way to study them [26].

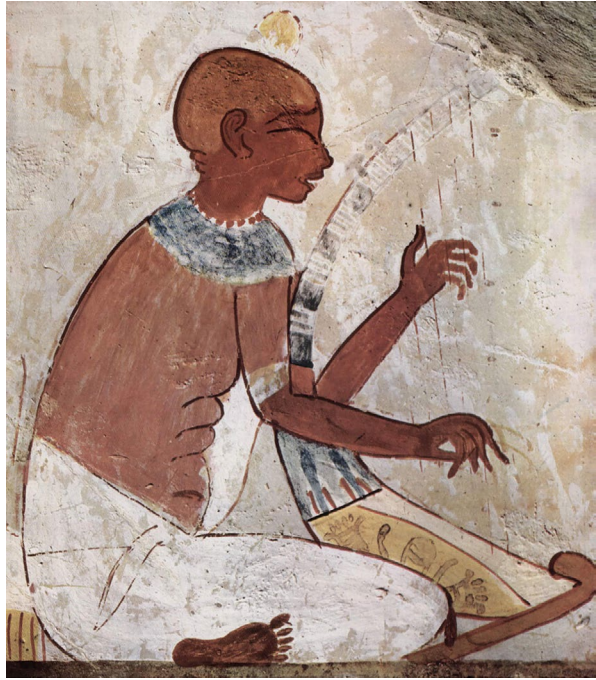
Along with the questionable treatments and diagnostic observations, we can also identify an array of other correct and incorrect assumptions. One frequently mentioned in neuroscientific histories is the Egyptian assumption that it was the heart, not the brain, that was the seat of perception, intellect, cognition, memory, and emotions. Indeed, like many Biblical and early Greek thinkers, we find the heart elevated over the brain in China, India, Egypt and throughout the world. Therefore, the heart was regarded as the spirit and soul of an individual. Phrases like “in my heart I know it’s right” still reflect this way of thinking. Plato’s tripartite theory of the brain is an exception here, although this in no way means all his ideas were error free. As discussed in Chap. 5, he had little regard for knowledge gained through our senses, although we know that our sensory system gives our brains knowledge about the world external to ourselves.

The importance of sensory experience in an individual’s life was captured in an emotional response to blindness penned by an Egyptian painter Poi (c. 1304–1237 BCE) in a letter to his son. Poi’s despondency over his vision loss shows that the despair that accompanies losing one’s ability to see was as real then as now.

Do not leave me. I live in despair ... I live in darkness. My god Amon has left me. Bring me honey for my eyes, and fat ... and genuine eye-paint, as soon as possible. Am I not your father? I wish to see, but my eyes are deserting me (p. 65, in [4]).

Artifacts and works of art additionally document maladies outside of the preserved medical literature. These, too, offer information about illness, health, emotions, and cultural views on well-being. When abnormalities and ailments are recorded, it is often unclear if the intention is to present symbolic ideas or if these serve as another example of how frequently cultural ideas are interwoven with views on biological change. Perhaps both.

Fig. 1.1 A mural of a blind musician playing a harp, from the tomb of the ancient Egyptian scribe called Nakht. c. 1422–1411 BCE. Courtesy of the Yorck Project



The blind Egyptian harpist (Fig. 1.1), a common motif in Egyptian art, also reminds us that the meaning behind an artifact is often unclear or symbolic. These musicians are generally represented singularly as a wealthy, well-dressed, bald, fat man. The harpist's baldness associated him with priests who shaved their heads to achieve ritual purity. The difficulty in dating the songs precisely matches the difficulty in interpreting the songs and the paintings. When Lichtheim studied the harpists' songs in the mid-twentieth century, she concluded they reveal the history of Egyptian attitudes toward death and the afterlife [27]. Since none of the harpist songs mention blindness, the inference is that the motif is purely symbolic, one intended to urge people to enjoy life on earth and stress the good to come in the afterlife, as the following refrain preserved in two New Kingdom documents conveys.

He is happy, this good prince!
 Death is a kindly fate.
 A generation passes,
 Another stays,
 Since the time of the ancestors (in [27]).

Debates as to what artistic works like the blind harpist say are not confined to their symbolic aspects. They also demonstrate that the brain interprets many factors when engaging with art, including the syntax of the presentation. In this case, the painter's syntax includes pigments, color, line, form, and so forth to convey and capture this

work's message, which may include representations of higher-order symbolic ideas or abstract concepts that are culturally known, as it appears the blind harpists do. In linguistics, such as the poetic words comprising the harpist's song, we see another kind of syntax. Here words and morphemes are combined to form the language the brain interprets and by extension the abstract and symbolic ideas conveyed through it. Musical syntax would include pitch, notes, rhythm, melody, harmony, texture, timbre and so forth. Perhaps this song was read or sung with inflections that added a musical nuance to its linguistic, visual, and symbolic rendering?

1.4 The Ancient Greeks and Etymology

Ruminations on how the mind, the body, and nature functioned as a whole were also passionately discussed in Ancient Greece. From Pythagoras (c. 570 BCE–c. 500 BCE) and Thales (fl. 550 BCE) onward, thinkers and physicians were developing elaborate theories. One acknowledgement of the Greek contributions is found in current terminology that connects neuroscience and art to later fields of inquiry in the West. For example, the Greek term *psyche* (spirit or mind) later served as the root of psychology and psychiatry, two areas defined as stand-alone fields in the nineteenth century. Other terms associated with neuroscience and art that have Greek roots include neurology and aesthetics. Both are discussed shortly. *Therapeutikos*, the Greek root for therapy, means to cure or treat medically [28]. Therapeutics is the focus of Chap. 9.

The use of Greek etymology emphasizes how directly Western assumptions about the mind, the brain, and culture trace back to many Greeks ideas. Yet, it is important to note that despite some theoretical connectedness, the Greek worldview was intrinsically unlike our own, or even that of the Renaissance. How their cosmobiological assumptions differed is largely overlooked when discussing their impact on neuroscience and art [18, 29], and thus important to note.

A cosmobiological view is one in which everything is seen as a connected biological system. As the influential etymologist Henry Watson Fowler points out, both the words physics and physiology are derived from the Greek work *physiologia*:

[*Physiks* and physiology] have now been narrowed and differentiated, physics retaining only the properties of matter and energy in inorganic nature, and physiology only the normal functions and phenomena of living beings (p. 427, [30]).

Physiologia, of course, is the root of physiology. When Jean Fernel (1497–1558), a sixteenth century French physician, introduced the term “physiology” to describe the study of the body's function, he said, “Anatomy is to physiology as geography is to history; it describes the theatre of events” (in [31]). When the term is used today to characterize how our bodies work, the term does not encapsulate the degree to which we live in a more bifurcated or specialized world than the Greeks, although theoretical conjectures surrounding it may. For the Greeks, however, physics (inorganic matter *and* nature) and physiology (nature *and* the body) were seen not just as

working in tandem; they were seen as inseparable [18, 29, 32]. The vagrancies of mind, disease, and the inexplicable that appeared to violate the cosmic harmony were more of a mystery. How this seamless perspective was evident in the ever-changing world at-large was vigorously debated and influenced thinking about natural philosophy (medicine, science, and philosophy).

In other words, the Greeks, like the Egyptians, took a serious interest in how all things work, and work in tandem, even the quite mysterious congenital conditions, and even though their conjectures about human physiology were based largely on animal studies. Physicians and philosophers contributed to these efforts to understand life, where it came from and how it was lived. For example, Hippocrates studied chicken embryos. Aristotle classified animal species and considered whether they reproduced by means of eggs, spontaneous generation (i.e., in smaller species and insects) or viviparity [26]. The physician Galen, too, offered hypotheses. He asked whether the embryo came from the white or the yolk of the hen's egg. These kinds of investigations fostered speculation [26], particularly in regard to brain formation and function.

Another term derived from the Greeks is anatomy, the branch of biology concerned with the study of the structure of organisms and their parts. The word is derived from the Greek word for dissection. Early anatomical investigations echoed the cultural rubric that assumed the proper goal was understanding how to achieve harmony between the parts and the whole of organisms. Human dissection was controversial and forbidden by law so comparative analyses were made through animal dissections and vivisections [4, 6, 33]. Because dissection was frowned upon for religious, moral, and cultural reasons, physicians and anatomists instead relied upon knowledge gained from minor surgeries. Exceptions to the legal restrictions did occur as well, including the work of Herophilus (335–280 or 255 BCE) and Erasistratus (c. 304–c. 250 BCE). While at the Alexandrian Museum, they put together a tripartite brain theory that was more anatomically informed than Plato's and included beliefs, emotions, and desires. This later model was somewhat modified by Galen of Pergamon (130–200) in the second century [34], who is discussed shortly.

Arete, another Greek term, reflects how Greek cosmobiological cultural mores referenced functional parts (humans) within the whole (society and/or the cosmos). Although *arete* is generally translated into English as virtue, it is more ambiguous. *Arete*, like many Greek terms, was used in both the microcosmic and macrocosmic sense to convey how working with (or within) the proper functional mode harmonized the whole. The idea was that all of us and everything has a certain function that we are intended to perform for our common humanity to achieve excellence. It could be a skill or efficiency at a particular job. The *arete* of a doctor is different from that of a warrior. For a warrior, one's function includes dying in battle; just as a physician's function is healing.

Individual bodies were seen in similar terms. So, in health and well-being, limit and order were considered good. The well-being of the world (or its harmony) and that of every creature in it depended on a proper mingling of the elements of which it is comprised. With the proper mingling, all is in a state of *harmonia* [32]. We

repeatedly see the urge for *harmonia* in descriptions of nature and the body's functions. One well known contributor here is Aristotle (384–322 BCE), Plato's student. His writings explain that every part of the body is formed for a purpose and that function could therefore be deduced from its structure.⁴ *Harmonia*'s medical formulation—humor theory—is credited to Hippocrates of Kos (460–377, BCE) and also connected to the Pythagoreans.

The Pythagorean tradition is important neuroculturally given that Pythagoras' (c. 570 BCE–490 BCE) most striking and enduring discoveries were in the field of music [32]. Although in many ways a mystical sect, the Pythagorean's also distinguished themselves from other Greek philosophers through their emphasis on form and order rather than the nature of matter. In addition, some say that Pythagorean thought influenced Plato in developing his ideas about Ideal Forms and the immortal soul. Pythagoras is particularly relevant neuroculturally because he identified that the pitch of a musical note is in inverse proportion to the length of the string that produces it, and that intervals between harmonious sound frequencies form simple numerical ratios [37]. When Hermann Helmholtz (1821–1894) published *On the Sensations of Tone as a Physiological Basis for the Theory of Music* (1863), as discussed in the next chapter, he referenced Pythagoras' contributions [38].

In addition, the Pythagorean idea of the music of the spheres or harmony of the spheres is still associated with his name, although the concept has various interpretations. In Chap. 12, when synesthesia is discussed, Pythagoras' influence is relevant again. At this point, his contributions are noteworthy in terms of medicine and humor theory because they influenced Greek thought overall. Indeed, his ideas about form and order flowed down through the ages, and were correlated with both music and the body through the idea of harmony:

Pythagorean, ideas were still regarded as canonical throughout the Middle Ages and beyond... [in] the study of medicine. Limit and order are good, and the well-being of the world and of every creature in it depends on a right mingling (*krasis*) of the elements of which it is composed. It is then in a state of *harmonia*, the word which (in Greek as in English) primarily applied to music being extended to cover the whole field of nature. To the microcosm this doctrine was applied in the theory that bodily health was dependent on the rightly proportioned mixture of the physical opposites: hot and cold, wet and dry. If they are in a state of *harmonia* in the body, then, as the doctor in Plato's *Symposium* puts it, the most mutually hostile elements in it are reconciled and taught to live in amity: "and by the most hostile I mean the most sharply opposed, as hot to cold, bitter to sweet, dry to wet." This dogma of the importance of maintaining—or restoring in the case of sickness—the right quantitative relationships between opposite qualities became the cornerstone of Greek medicine, which started in a Pythagorean atmosphere with the work of Alcmaeon of Croton (pp. 38–39, [32]).

Work attributed to Hippocrates of Kos is also associated with humor theory, although his work is now seen as the compilation of research notes by a school of physicians

⁴Aristotle's three great books on biology were *History of Animals*, *Parts of Animals*, and *The Generation of Animals*. One fascinating part of his contributions is his diagram of the "ladder of nature" (*scala naturae*), demonstrating the breadth of his interests in the whole animal kingdom, plants, and inanimate materials [35, 36].