

## Notes

### Introduction

1. For the place of music in the formation of physicians, see Kümmel 1977, 63–88.
2. Wellmann 2017 discusses the significance of rhythm in the biological sciences in ways that are complementary to my approach here.
3. Walker 1975, 1978, 1985; Gouk 1980, 1982, 1999, 2000a, 2000b; 2004, 2014, 2015; Kümmel 1977; Kassler 1995, 2001.
4. Kennaway 2012a, 2012b, 2014, 2015, 2016, 2019; Davies and Lockhart 2016; Lockhart 2017; Pottinger 2020; Raz 2014; Raz and Finger 2019; Steege 2011, 2012; Trippett 2018, 2019; Trippett and Walton 2019; Volmar 2012, 2013a, 2013b, n.d.; Wolf 2015.
5. Bijsterveld 2019; Pinch and Bijsterveld 2012; Brain and Wise 1994; Brain, Cohen, and Knudsen 2007; Brain 2015; Brittan 2011, 2017, 2019; Hadlock 2000; Hui, Kursell, and Jackson 2013; Hui 2013a, 2013b; Jackson 2004, 2006; Kursell 2011, 2013, 2015; 2018, 2019a, 2019b; Pantalony 2004, 2009; Prins 2012; Prins and Vanhaelen 2018; Rice 2011; Thompson 2002; Tkaczyk, Mills, and Hui 2020.
6. Kittler 1999, 2006, 2014; Sterne 2003; Erlmann 2010; I also found Schwartz 2011 a wonderful resource.
7. For an overview, see Davis 2017.
8. Longrigg 1993; Jouanna 1999, 2012; Nutton 2004; Siraisi 1990, 1975; Boner 2013; Cheung 2010; Finger 1994, 2000; Finger and Piccolino 2011; Duffin 1998; Nicolson and Fleming 2013.
9. For the history of otology, see Erlmann 2010; for bird and animal vocalization, see Catchpole 2008; Rothenberg 2008; Bruyninckx 2018.
10. For the history of chronobiology, see Daan 2010; for entrainment, see Pesic 2017, 267; for embryology, see Wellmann 2017.
11. See Harrington 1996, 34–71; Clements 2011; Gómez 2013. See also Trippett 2018, 208–216.
12. See Maslow 1966, 15–16.

### Chapter 1

1. Longrigg 1993, 8–11.
2. *Iliad* 1:46–52.
3. *Ibid.*, 1:472–474, as translated in Homer 1990, 15.
4. *Odyssey* 4:220–232. Translations not otherwise identified are my own.
5. Nutton 1995, 17. For the relation of medicine to pre-Socratic philosophy, see also Jouanna 1999, 259–269.
6. For a thoughtful treatment of the Pythagoreans' worldview and its influence, see Heller-Roazen 2011.
7. Pesic 2014b, 9–13.

8. Vogel 1966, 242. See also Schumacher 1963, 1965.
9. Provenza 2012, 93, argues that this was no invention of the Pythagoreans but “a manifestation of a very ancient practice, well attested in Greek culture, which resulted from the strong relation between religion and medicine” (95).
10. Iamblichus 1989, 49. See also West 1992, 32.
11. As cited in Provenza 2012, 100n43.
12. *Ibid.*, 101, probably quoting Aristotle’s lost work on the Pythagoreans.
13. Vogel 1966, 232–244, at 233. For the medical context in southern Italy, see also Burkert 1972, 292–294.
14. Riedweg 2005, 2–5, at 3; about the secret society, see 98–104.
15. See Burkert 1972.
16. *Metaphysics* 986a22ff, as translated in Longrigg 1993, 45, who discusses the relation between Alcmaeon and the Pythagoreans on 48–51.
17. Zhmud 2014, 98; Longrigg 1993, 47–63, at 48.
18. According to the Roman Aetius, cited in Longrigg 1993, 52.
19. According to Zhmud 2014, 99.
20. *Ibid.*, 100.
21. Huffman 1993, 15.
22. As translated in *ibid.*, 93.
23. *Ibid.*, 75, 307.
24. *Ibid.* 84, discussing the concept of *archai* on 78–92.
25. In his celebrated treatment of the quadrature of lunes, see *ibid.*, 80. This Hippocrates should be distinguished from the famous physician from Cos.
26. His student Archytas, who made important mathematical discoveries, also used language that paralleled that in Hippocratic texts. See Huffman 2005, 58–59, 89–90.
27. See Jouanna 1999, which gives an annotated list of this corpus (373–416) and discusses its authorship (56–71).
28. See *ibid.*, 181–209.
29. See Lane Fox 2020, 112–118, who notes that these case histories were special to the Epidemic books in the Hippocratic corpus.
30. Jouanna 1999, 162–170, 344–346; Iamblichus 1989, 102.
31. *Regimen* 61, Hippocrates 1937, I.8.10–18 (243–245).
32. Jouanna 1999, 128–131.
33. *Phaedo* 115d, 117c (Plato 1997, 98–99). Subsequent citations from Plato generally include the reference for this translation, in parentheses.
34. *De natura hominis* I:10–12, II:1–2. I have used the generic “human being” (rather than “man”) to translate *anthropos*, reflecting standard Greek usage.
35. *Ibid.*, IV:4–10. For Hippocratic humorism, see Jouanna 1999, 314–317.
36. See Lane Fox 2020, 233. For the later history of the humors, see Jouanna 2012, 335–359.
37. See Lane Fox 2020, 57.
38. See Jouanna 1999, 335–341, and Lloyd 1987, 257–270.
39. See “Father Time” in Panofsky 1972, 69–93, on 71–75; gradually Chronos was conflated with Kronos or Saturn, oldest of the gods, who devoured his own children. In “Of Isis and Osiris,” Plutarch noted that “the Greeks are used to allegorize Kronos (or Saturn) into chronos (time), and Hera (or Juno) into aer (air) and also to resolve the generation of Vulcan into the change of air into fire.” For later uses of *kairos*, see Baert 2016.
40. *Precepts* 1.1–3.
41. As suggested by Lloyd 1970, 58.

42. “Pythagorici numerici” in his *De medicina* 3.4.15, cited in Longrigg 1993, 98.
43. See, for example, *Epidemics* 1.23–26, cited in Lloyd 1984, 100–101. For fevers, see Jouanna 1999, 150.
44. *Aphorisms* 1.20, cited in Lloyd 1984, 208.
45. *Epidemics* 1.11, cited in Lloyd 1984, 94.
46. Jouanna 1999, 341, finds the association with Pythagoreanism “tempting” but notes that “the period judged perfect by the Pythagoreans, the decade, plays no important role in the reckoning of critical days among the Hippocratic physicians” so that we should not conclude that “all arithmological analysis was Pythagorean.”
47. Osler 1947, 49, as pointed out by Lloyd 1984, 32n.
48. Lloyd 1987, 260–261.
49. Hippocrates 1937, I.8.10–18 (243–245). See also Burkert 1972, 262–263.
50. Hippocrates 2010, 87–89, at 89.
51. Burkert 1972, 290–295. See also Lloyd 1970, 50–65 at 51.
52. Iamblichus 1989, 102; Vogel 1966, 235.
53. Regarding the Hippocratic Oath versus the oath sworn by the Asclepiads, see Jouanna 1999, 50–52, who discusses Hippocrates as a member of the Asclepiads on 10–12.
54. *Protagoras* 311c (749), *Phaedrus* 270b–d (547). See also Jouanna 1999, 5–7.
55. As asserted by Longrigg 1993, 108–148, at 147, who discusses his relation to Sicilian medicine on 108–148.
56. Pliny, quoted in *ibid.*, 105.
57. See Huffman 2005, 3, 32–35, 41, 44.
58. *Phaedo* 61e–62e (53–54).
59. For these terms, see Lloyd 1970, 51, who does not connect them to the *Timaeus*.
60. *Timaeus* 69c (1270–1271).
61. *Ibid.*, 30a (Plato 2016, 15).
62. *Ibid.*, 53c–57d (Plato 1997, 1256–1260).
63. *Ibid.*, 69c (1270–1271).
64. *Ibid.*, 41e (1245).
65. *Ibid.*, 90a (1289).
66. *Ibid.*, 78a–81e (1278–1281).
67. *Ibid.*, 88b (1287).
68. *Ibid.*, 89a (1288).
69. *Republic* 424c (1056).

## Chapter 2

1. *On the Heavens* 306a9–11 (Aristotle 1984, 1:500). Subsequent citations of Aristotle reference this edition in parentheses.
2. *Metaphysics* 985b24–26, 1090a24–25 (Aristotle, 2:1559, 1722).
3. *Ibid.*, 1090a32–34, 1090b20 (Aristotle, 2:1723).
4. *Problems* 11.24, 42, as translated in Barker 2004, 2:93, 96
5. *Parts of Animals* 645a17–25 (Aristotle, 2:1004). For the effect of Aristotle’s work in biology, see Longrigg 1993, 149–176.
6. Forster 2014, 22. The second quote is from von Staden 1989, 25.
7. Nutton 1995, 33–34.
8. Lewis 2017, 6–9.

9. However, Herophilus and his followers were critical of Hippocratic medicine; see Jouanna 1999, 63. Note the alternate spelling, “Herophilos”; the Latin version, Herophilus, is more commonly used.
10. Vesalius 2002, 3:45.
11. For his milieu and discoveries, see Harris 1973, 177–195; Nutton 1995, 34.
12. von Staden 1989, 38–39, citing Hyginus, *Fabula* 274.13. The alternate spelling “Agnodice” is also found.
13. According to *ibid.*, 269–271.
14. *Ibid.*, 278–279, 346. Wellmann 2017, 68, also comments on Herophilus’s use of rhythm.
15. Galen, *Synopsis librorum suorum de pulsibus*, as cited in von Staden 1989, 355.
16. *Ibid.*, 355–356.
17. *Ibid.*, 356.
18. *Ibid.*, 351.
19. Euclid, *Elements* VII, definition 2, and V, definitions 3, 4. Note also the careful clarification of “being in the same ratio” in definition 5.
20. According to Aristotle, fragment 519 R<sup>3</sup> (Aristotle 1984, 2:2455). For its warlike character, see Plato, *Laws* 815a. Also called *pyrrhios*, it is still widely danced in Greece, including a mass performance staged for the opening of the 2004 Olympics in Athens.
21. Edgar Allan Poe, “The Rationale of Verse.”
22. From his poem “The Garden.”
23. The accent marks shown in Greek texts record a pitch, not a stress, accent.
24. The Hopkins line is from his “Pied Beauty,” the Shakespeare from Sonnet 18. See von Staden 1989, 351.
25. *Ibid.*, 349.
26. *Ibid.*, 348.
27. Harris 1973, 397–431 at 410–418.
28. Von Staden 1989, 344–346.
29. According to Marcellinus, *De pulsibus* 11.463.260–267, cited in von Staden 1989, 354.
30. Lloyd 1987, 284.
31. Von Staden 1989, 288. For the work of Erasistratus, see Longrigg 1993, 205–219.

### Chapter 3

1. Pliny, *Naturalis historia* 11.89.219, cited in von Staden 1989, 360.
2. Pliny, *Naturalis historia* 29.4.5–29.5.6, cited in von Staden 1989, 359.
3. See the discussion of the Pneumatic school of medicine in *ibid.*, 285n158.
4. For Galen in relation to other medical sects of his time, see Sarton 1954, 30–38.
5. Galen, *De uteri dissectione*, cited in von Staden 1989, 143.
6. Galen, *On Medical Experience*, cited in von Staden 1989, 287–288.
7. *Ibid.*, 288n166.
8. Thorndike 1923, 1:144.
9. Von Staden 1989, 346–347.
10. *Ibid.*, 285–286.
11. *Ibid.*, 358.
12. For Galen’s pulse theory, see Harris 1973, 397–431.
13. See Siraisi 1975, 689–710, at 697–698.
14. Censorinus, *De die natali* 12.4–5, cited in von Staden 1989, 360. Censorinus also related musical numbers and astrology to embryology; see the excerpts in Godwin 1988, 17–19; 1993, 40–45.

15. Iamblichus 1891, 93 (sec. 32, lines 11–18) as translated in Lloyd 2013, 155–156.
16. For Aristides’s life and the dating of his work, see Aristides Quintilianus 1983, 10–14.
17. *De musica* 106.9–20, as translated in Barker 2004, 2:506.
18. Ibid.
19. Ibid., 31.4–9 (2:433). Wellmann 2017, 21–28, comments on the development of this concept.
20. Barker 2004, 83.12–14 (2:434).
21. Ibid., 83.19–20 (2:434).
22. Ibid., 83.18–25 (2:486).
23. Ibid., 89.10–15 (2:491); for the breath, see 492n199.
24. Ibid., 89.15–25 (2:491–492).
25. Ibid., 82.26–28, 14–15 (2:485).
26. This was remarked by the music theorists Adrastus (first century CE) and Panaetius, whose own works were lost but whose ideas were recounted by Theon and Porphyry in the third century; see Barker 2004, 2:214, 238. One wonders whether they, unlike Aristotle’s students, really observed this themselves; the octave is by far the loudest of sympathetic vibrations, though other concords will indeed selectively resound more faintly. In saying “concords,” did they mean to include a specific list, or were they merely copying Aristotle’s *Problems* inaccurately?
27. Ibid., Aristides *De musica* 86.22–23, 89.92–95 (2:489, 492), emphasis added.
28. Ibid., 89.85–95 (2:492).
29. Ibid., 106.18–20 (2:506).
30. Ibid., 30.20–24 (2:433).
31. Ibid., 55.29–56.4 (2:460).
32. Ibid., 58.11, 14–17 (2:462).
33. Ibid., 58.22–29 (2:462–463).
34. Ibid., 64.22–65.1 (2:468).
35. Ibid., 68:24–28 (2:471–472).
36. *On the Nature of Man* sec. 9, Lloyd 1984, 266.
37. Barker 2004, 40.13–15 (2:445). See also Palisca 2006, 75–77.
38. Henderson n.d., 454–455.
39. Strunk and Treitler 1998, 46.
40. Pesic 2017, 140–145, 197, 209.
41. The first five books were written in Milan (387) before his baptism, after which he returned to Africa and composed a sixth book in 391; see Augustinus 2002, x–xxviii.
42. For *numerus* as rhythm, see *ibid.*, 7n1.
43. Ibid., 9 lines 25–27.
44. Ibid., 15 lines 9–14.
45. Ibid., 15 lines 15–18.
46. Ibid., 15 lines 23–25.
47. Ibid., 113 lines 1–7.
48. Ibid., 113 lines 18–22.
49. For the relation to Aristides, see Aristides Quintilianus 1983, 5.
50. Von Staden 1989, 361.
51. Boethius 1989.
52. Ibid., 7 [186], showing the standard page numbers from Boethius 1867 in square brackets.
53. Ibid., 10 [189].

54. Ibid., 3 [181], 5 [184].
55. Ibid., 5 [185].
56. Ibid., 6 [185].
57. Martianus Capella 1977, 1:55.
58. Von Staden 1989, 361.
59. Hrotsvit of Gandersheim 1989, 100. For Hrotsvit’s use of music, see Chamberlain 1980.
60. Hrotsvit of Gandersheim 1989, 113.
61. Adamson 2006, 3.
62. Ibid., 162.
63. Ibid., 165.
64. Cited in *ibid.*, 172.
65. Ibid., 173.
66. Ibid., 174, which only addresses the first two strings. Jouanna 2012, 335–359, notes the ambiguity of phlegm in Galen, who sometimes describes it as having “no effect on the character of the soul” (340), elsewhere as associated with despondency and forgetfulness (342).
67. See the excerpt from his “Maxims of the Philosophers” (*Nawadir al-falasifa*) in Godwin 1993, 91–98, at 97.
68. Qiftī 1903, 361; Kümmel 1977, 61.
69. See the excerpt included in Godwin 1993, 112–122.
70. Sarton 1975, 2: part 1, 76.
71. Khodadoust et al. 2013, 291.
72. Ibid., 292.
73. Following the more recent translation of Holford-Strevens 1993, 475–476. The sections of the *Canon* on the pulse can be found in Abu-Asab, Amri, and Micozzi 2013, 200–221. Though not a scholarly edition, this translation was prepared from the original Arabic, unlike Gruner 1970, 283–322, which was based primarily on the medieval Latin translation.
74. See Holford-Strevens 1993, 476–477.
75. Ibid., 476.

## Chapter 4

1. Paxton 1993. In this practice, the seven penitential psalms were emphasized.
2. Sweet 2006, 93–123, at 98. See also Glaze 1998.
3. Cited from Silvas 1999, 160–161. See Fassler 1998, 149–175, at 150.
4. *Causae et curae* 2:84:15–24, as translated in Sweet 2006, 99 (with some adjustments of the numerical nomenclature of parts).
5. Bingen 1999, 135. Cf. Cannon 1993, 84–86.
6. Ibid.
7. Bingen 1990, 532–533.
8. Bingen 1987, 358–359.
9. Ibid., 121.
10. For instance, see her description of the cosmos as a “vast instrument, round and shadowed, in the shape of an egg” in Bingen 1990, 93–98. For her description of the “harmony of the heavens,” see Bingen 1994, 9–10.
11. Callahan 2000, 159.
12. Ibid.

13. Crombie 1995, 27. For his knowledge of medicine, see Crombie 1971, 75–76.
14. Baur 1912, 4–5.
15. Thorndike 1923, 2:436–453 at 445.
16. According to *ibid.*, 158. For the development of medical education, see Siraisi 1990, 48–77.
17. For a survey of this period, see Kümmel 1977, 26–33.
18. For the school of Salerno, see Thorndike 1923, 1:731–741, and Siraisi 1990, 13–14, 57–58.
19. Capparoni 1936. On the Salernitan school, see Lawn 1963; Siraisi 1990, 13–14, 57–58; de Divitiis, Cap-pabianca, and de Divitiis 2004.
20. Ausécache 1998, 211. For Gilles’s discussion of the dactylic meter in pulse, see Choulant 1826, 30.
21. Holsinger 2001, 173–175.
22. Palisca 1985, 51–66, at 54.
23. *Ibid.*, 51, 54–55, 51.
24. Siraisi 1975, 691. For a survey of Peter’s work, see Thorndike 1923, 2:874–947.
25. See Vecchi 1967.
26. See the discussion in Pesic 2017, 47–66. For rhythmic notation in this period, see Earp 2018; figure 4.2 only gives the barest outline for an evolving rhythmic notation that had many subtleties.
27. See Kibre 1978.
28. Vescovini 1987, 30–32.
29. Siraisi 1975, 692, thinks that Gentile treats the topic with “disdainful brevity,” though still endorsing it.
30. Quoted from *ibid.*, 694.
31. The spelling “Ramis” is also found; see the helpful discussion in Tomlinson 1993, 78–84.
32. Ramos de Pareja 1993, 110.
33. For al-Kindi’s influence on Ficino, see Ficino 1989, 28, 48, 50, 51, 83, 86, and Prins 2012, 399.
34. See above, chapter 3.
35. Ficino 1989, 361; also available in Strunk and Treitler 1998, 385–389, at 388. Subsequent references show this latter reference in parentheses.
36. Ficino 1989, 357 (387).
37. Gouk 2004, 100.
38. First quote from Ficino letter 5, cited in Seta, Pirrotta, and Piperno 1989, 129.
39. Plotinus 1992, 369–370 (IV.4.40–41). See also Burnett 2018.
40. Ficino 1989, 361 (388).
41. *Ibid.*, 361 (388–389).
42. See Farndell 2010, 68–69.
43. Ficino 1989, 361 (389).
44. *Ibid.*, 359 (388).
45. Gaffurius 1969, 69, whose name is also given as Franchino Gafori. See also Bonge 1982, 168.
46. *Ibid.*, 169–170, which discusses the problems of translation in these passages.
47. See Haar 1974, 81–82.
48. For Ficino, see Tomlinson 1993; for Campanella, see Walker 1975, 205–212.
49. See McDonald 2018.
50. Cited in *ibid.*, 164.
51. For instance, the Zurich preachers Johann Ulrich Surgant (1502) and Heinrich Bullinger (1525), as well as the Nuremberg physician Ulrich Pinder (1510); see *ibid.*, 168–169.
52. See Schleiner 1991.

53. McDonald 2018, 169.
54. Agrippa von Nettesheim 1992, 2.25, quoted from Agrippa 1993, 323–324, and cited in McDonald 2018, 169.
55. Agrippa von Nettesheim 1993, 345–354 at 351.
56. *Ibid.*, 339.
57. Note that the four final notes correspond to the main division of the modes into *protus* (D), *deuterus* (E), *tritus* (F), and *tetradsus* (G), each having two versions: “authentic” (in which the final is at the bottom of the range of the mode) and “plagal” (the final near the middle of the range).
58. Liban 1975, fol. F1r, as translated in McDonald 2018, 171.
59. *King Lear* IV:vii stage direction; *The Tempest* V.i.54–55; III.ii.129–130.
60. For the imagery in figure 4.6, see Mueller 1949.
61. Burton 1989, 2:3 (367).
62. See Pesic 2017, 137–145.
63. For the use of music as a stimulus, see Kümmel 1977, 324–344, which treats music as sedative on 344–362.

## Chapter 5

1. Regier 2014, 1. All citations from Kepler’s collected works, Kepler 1937, will be listed as KGW.
2. Caspar 1993, 109. Kepler was well enough informed about human pulse to make salient comparisons with astronomical time; see KGW 7:180, and Kümmel 1977, 48.
3. Jardine 1984, 228.
4. Rosen 2003, 44n62. See also Rothman 2017, 200.
5. Regier 2014, 1.
6. Rosen 2003, 43.
7. Kepler 2015, 47; KGW 3:19; as translated in Regier 2014, 9.
8. Boner 2013, 41, citing Kepler 1937, 4:177.18–25. See also Jardine 1984, 223–224, at 151, and Regier 2014, 8.
9. Boner 2013, 42; KGW 11, 2:48.23–28.
10. Boner 2013, 42; KGW 14, no. 130:640–651.
11. Escobar 2008, 32. See also the helpful discussion in Regier 2014.
12. Boner 2013, 169.
13. Kepler 1997, 387.
14. *Ibid.*, 304.
15. Quoting Stephenson 1994, 2.
16. Kepler 2010, 33. See the helpful introductions by Owen Gingerich (3–11) and Guillermo Bleichmar (15–22); see also Pesic 2000, 87–90.
17. Kepler 2010, 85.
18. *Ibid.*, 89.
19. *Ibid.*, 93.
20. *Ibid.*, 113.
21. KGW 1:268.26–38, as translated in Boner 2013, 31n113.
22. *Ibid.*, 31.
23. Regier 2014, 1.
24. *On the Generation of Animals*, 736b29–737a1 Aristotle 1984, 1:1143.



25. Boner 2013, 32.
26. *Ibid.*
27. *Ibid.* 123; KGW 8:131.3–6.
28. Boner 2013, 113–114; KGW 8:216.37–39, 1:341.1–3. For helpful cautions about the meaning of “physiology” in this context, see Schechner 1997, 100, 143, 148–149, 259.
29. Boner 2013, 105; KGW 4:62.22–24, 19–22.
30. Caspar 1993, 184.
31. Boner 2013, 35, 107; KGW 15: no. 394, 74–78; 4:74.41–75.1.
32. Boner 2013, 159, 66; KGW 6:261.25–26, 16: no. 488, 42–44.
33. See Kepler 1997, 330–333.
34. Boner 2013, 66–67; KGW 16: no. 488, 93–95.
35. Boner 2013, 33n126; KGW 4:140.40–43. See also Juste 2010.
36. Boner 2013, 67.
37. Boner 2013, 154; KGW 6:406.32–37.
38. See Kepler 1997, 439–450, and Pesic 2014, 78–88; 2017, 145–147.
39. Boner 2013, 86–87; KGW 1:317.21–30.
40. Boner 2013, 87; KGW 1:317.37–318.2.
41. Boner 2013, 96–97; KGW 1:288.24–28.
42. See Rothman 2017, 188–197, which treats his relation to James on 200–203.
43. For James’s visit to Tycho, see Thoren 1990, 334–335; Christianson 2002, 140–141. For Kepler’s dedication, see Kepler 1997, 2–5, at 3.
44. Kepler 1997, 3–4.
45. *Ibid.*, 4.
46. *Ibid.*, 4–5.
47. *Ibid.*, 5.
48. *Ibid.*, 255–279.
49. See Rothman 2017, 204–216, for Kepler’s relation to Bodin.
50. See Orr 2016.
51. Kepler 1997, 276.
52. *Ibid.*, 275.
53. *Ibid.*, 276.
54. Boethius 1989, 65–66 [242].
55. Kepler 1997, 446.
56. See Pesic 2000, 96–112.
57. See Pesic 2014, 82–86; 2017, 146.
58. For allusions to Ficino, see Kepler 1997, 322n41, 363n78.
59. For his relation to Wallenstein, see Caspar 1993, 338–345.
60. Kepler 1997, 308n28.
61. *Ibid.*, 309n29; Caspar 1993, 339.
62. Kepler 1997, 373.
63. Caspar 1993, 339–340.
64. As translated in *ibid.*, 341, 342.
65. *Ibid.*, 342.
66. *Ibid.*

67. For instance, Kepler thought that the configuration of the heavens sixty-four minutes after his own birth foretold a “nearly fatal fever” he had undergone at age sixteen. See Boner 2013, 61–62; KGW 13: no. 117, 347–355.

## Chapter 6

1. Morton 1969, 180–181, discussed in Daboo 2010, 1–2.
2. For instance, this was the view of Sigerist 1948, 113–114.
3. *Ion* 536c (Plato 1997, 945). See the insightful discussion of musical possession in Tomlinson 1993, 145–188.
4. As translated in De Martino 2005, 214. For the larger context, see Walker-Meikle 2014.
5. De Martino 2005, 217.
6. Ficino 2005, 363 (389).
7. Tomlinson 1993, 164–165.
8. *Ibid.*, 125.
9. *Ibid.*, 124–125.
10. Valletta 1706, as translated in De Martino 2005, 124–125.
11. For the relation of the Christian church to dance, see Daboo 2010, 93–99, at 95.
12. Acts 28:3.
13. Daboo 2010, 109–110.
14. *Ibid.*, 110–111.
15. De Martino 2005, 221.
16. *Ibid.*, 102.
17. Daboo 2010, 114.
18. Quoted from *ibid.*, 113.
19. Ferdinandus 1621, 248; the modern edition by Arcuti 2002, 28, will subsequently be cited in parentheses. Translation mine.
20. Ferdinando specifies the left hypochondrium. In what follows, I shall use “tarantula” in this sense, noting that this term should not necessarily be understood as restricted to any particular species of arachnid.
21. *Ibid.*, 248 (27).
22. *Ibid.*, 254 (48).
23. *Ibid.*, 253 (46).
24. *Ibid.*, 264 (91).
25. *Ibid.*, 264–266 (91–97).
26. *Ibid.*, 266 (97).
27. *Ibid.*, 254 (50).
28. *Ibid.*, 261 (77–78).
29. *Ibid.*, 262 (81).
30. *Ibid.*, 262 (61–62).
31. *Ibid.*, 254 (51).
32. *Ibid.*, 258 (67).
33. *Ibid.*, 254, 258 (51, 66).
34. *Ibid.*, 258 (66).
35. *Ibid.*, 259 (69).
36. *Ibid.*, 258–259 (68).

37. Ibid., 250 (32–33).
38. Ibid., 266 (100).
39. Ibid., 267 (101).
40. Ibid., 261 (79).
41. Ibid., 267–268 (104).
42. Ibid., 258 (66–67).
43. Findlen 2004a, 1–48, at 1, which gives an excellent overview of his work and the controversies surrounding it.
44. Mayer-Deutsch 2004, 111.
45. *Ion* 55d–e (Plato 1997, 941).
46. Daboo 2010, 121. See also Cadenbach 2007.
47. As translated by De Martino 2005, 95.
48. Daboo 2010, 125.
49. Baldwin 2001, 90.
50. Daboo 2010, 127, translating from Kircher 1643, 872. The following citations indicate the original pagination in parentheses.
51. Ibid., 128 (873).
52. Ibid., 129 (768).
53. Findlen 2004b, 22.
54. As translated in Caminietzki 2004, 322–323.
55. Ibid., 321 (348).
56. Arcuti 2002, 251 (38); Baglivi 1696, 341; 1723, 370. All citations from this work follow this translation, cited in parentheses.
57. Baglivi 1696 288 (313).
58. Ibid., 287 (312).
59. Ibid., 309 (335–336).
60. Ibid., 294 (319).
61. Ibid., 321 (349).
62. Ibid., 322 (350).
63. Ibid., 322–323 (350–351).
64. Ibid., 332–333 (361–362).
65. Ibid., 333 (362).
66. Ibid., 336 (365).
67. Ibid., 310–311 (335–336).
68. Ibid., 16 (18–19).
69. Ibid., 152 (175).
70. Ibid., 274 (304).
71. Ibid., 210–211 (240).
72. For instance, Serao 1742, 198, cites an unnamed “valiant doctor” who became convinced of the reality of tarantism and used “crisis” to describe its climactic phase.
73. Baglivi 1696, 341 (370).
74. Ibid., 339 (368).
75. Ibid., 340 (368–369).
76. Ibid., 342 (371).

77. Ibid., 343 (372).
78. Ibid., 343–344 (372–373).
79. Ibid., 344 (373).
80. Ibid., 305 (331).
81. Ibid., 308–309 (334–335).
82. Ibid., 320–321 (348).
83. Ibid., 317 (344).
84. Daboo 2010, 141.
85. On Serao, see *ibid.*, 141–143.
86. Ibid., 143; De Martino 2005, 239.
87. Daboo 2010, 145.
88. Serao 1742, 169.

## Chapter 7

1. For a compendious survey, see Berg 1942. This history is carried forward in the more modern treatments by Grmek 1970 and Cheung 2010.
2. *Iliad* 4:122 (*neuron* as bowstring); 17:522 (*is* as sinew); Plato, *Timaeus* 82c–d, 84a (Plato 1997, 1282–1283).
3. Berg 1942, 337–338.
4. Von Staden 1989, 192–193.
5. Galen 2014, 260–319 (Book III, chapters 8–14). See Berg 1942, 346–347.
6. Galen 2014, 268–269.
7. As noted by Forrester in Fernel 2003, 1.
8. Forrester in Fernel 2003, 4.
9. Fernel 2003, 279 (79). Page numbers in parentheses refer to the original edition, Fernel 1567.
10. Ibid., 245 (68).
11. Fernel 2003, 321, 323; see Cheung 210, 70–73.
12. Fernel 2003, 329 (94).
13. Vesalius 2002, 45 (275 [375]). Page numbers in parentheses refer to the original edition, as reproduced in Vesalius 1964. Page numbers in brackets refer to the corrected page numbers of this edition.
14. Cicero, *De natura deorum* 2.133.13; cf. Garrison n.d. See also Kusukawa 2012, 216–218.
15. As noted by Lind in Vesalius 1969, xix–xx.
16. See Vesalius 2002, 3:2–3; 1998, 1:4–5.
17. On the originality of this mode of representation, see Singer 1926, 126.
18. Vesalius 1969, 1, 57.
19. Berg 1942, 325–355 at 352, 457.
20. See Krakeur and Krueger 1941, 219–232.
21. Ibid., 140.
22. Ibid., 168. See also Lindeboom 1979; Aucante 2006, 177–178, 193, 236, 421. For the larger context of Descartes’s views, see Gaukroger 1995, 17–19, 394–395; 2002, 224–226.
23. As noted by Cheung 2010, 75.
24. Ibid., 73–74, 76 (Grew).
25. Hooke 1961, 1.
26. Ibid., 8.
27. Ibid.

28. Ibid., 113.
29. Ibid., 114.
30. Berg 1942, 373. Original entirely in italics.
31. Grmek 1970, 398.
32. Hooke 1961, 12.
33. Ibid., 16.
34. Ibid., 15.
35. Ibid.
36. Ibid., 15–16.
37. Ibid., 28, 30.
38. Ibid., 173.
39. Hooke 1678, 1.
40. Ibid., 2, 6.
41. Ibid., 6.
42. Ibid., 4.
43. Ibid., 5.
44. Ibid., 9.
45. Ibid.
46. Ibid., 11.
47. Ibid., 13–16.
48. Ibid., 16.
49. Willis 1681, 96. See the helpful discussion in Wallace 2003, 79–80.
50. Willis 1681, 126, 128.
51. Wallace 2003, 80.
52. As argued by *ibid.*, 68–80.
53. Thoreau 1993, entry for September 5. Regarding metaphor in science, see Pesic 2017, 257–258.
54. Croone 2000, 75. In fact, this short treatise was appended to Willis’s *Cerebri anatome*, causing some confusion about its authorship.
55. Croone 2000, 77. Regarding his theories, see Wallace 2003, 80–82.
56. Croone 2000, 77.
57. Ibid., 77–79.
58. Ibid., 79–81.
59. Borelli 1989, 8–9.
60. Ibid., 119, replacing this translation’s “zither” by the original term, “kithara.”
61. Ibid., 120.
62. Borelli 2015, 206.
63. Ibid., 147.
64. Ibid., 147, 168.
65. Ibid., 169.
66. Borelli 1989, 271–273.
67. Ibid.; on the spiral action, see also 257–260.
68. Ibid., 258.
69. Ibid., 318–319.
70. Borelli 233.

71. Ibid., 233–234.
72. Ibid. 234.
73. Ibid.
74. Ibid., 398–399.
75. Ibid., 354, refers to Glisson among other “distinguished authors.” See Temkin 1964. For a general survey, see Berg 1942, 386–390.
76. Verworn 1913, 2–5, at 4.
77. Glisson 1677, 198.
78. Baglivi, *De praxi medica*, 322 (349).
79. Ibid., 249 (279).
80. Ibid., 227 (257).
81. See the excellent survey by Darrigol 2007.
82. See Berg 1942, 407–409, 420–426. Quote from Haller 1974, 7.
83. For these experiments, see Haller 1936; Steinke 2005; Eichberg 2009.
84. Bonnet 1770, 257.
85. Cheung 2010, 81–92, at 82n33.
86. See *ibid.*, 83–84.
87. Ibid., 84–87, at 86.
88. Bonnet 1755, 13–14.
89. Bordeu 1818, 2:802.
90. Krakeur and Krueger 1941.
91. Diderot 1875, 2:30–35, at 30.
92. Ibid., 2:33.
93. As argued by Christensen 1993, 133–68, at 138n19. See also Christensen 1994.
94. More generally, see Lockhart 2017, 19–84, for a helpful discussion of animated statues. She emphasizes Étienne Bonnot de Condillac’s *Traité des sensations* as giving a theoretical basis for such animation (19–43) in terms of sympathetic vibrations.
95. Diderot, *Œuvres complètes*, 5:477. My translation; see also Diderot 1964, 79. Further references cite their versions in parentheses, where applicable.
96. Ibid., 5:468 (71).
97. Ibid., 1:408.
98. Ibid., 9:279.
99. “Réfutation suivie de l’ouvrage d’Hélvetius intitulé De l’homme” (1774), *ibid.*, 2:367–368.
100. “Salon de 1763,” *ibid.*, 10:210.
101. “La rêve de D’Alembert,” *ibid.*, 2:113 (100). Note that this work only appeared in 1830, though it was written in 1769.
102. Ibid.
103. Ibid., 114 (101).
104. Ibid., 114–115 (100–101).
105. Ibid., 2:123 (109).
106. Ibid., 2:141 (126).
107. Ibid. (126–127).
108. Ibid. 2:141–142 (127).
109. Ibid., 2:143 (128).
110. Darwin 1796, 1:367; Schwartz 2011, 157.

## Chapter 8

1. This *regard médical* is the keynote of Foucault 1972. Even when he tries to include “the tactile and auditory dimensions,” Foucault still asserts that they remain “under the dominant sign of the visible”; Foucault 1994, 165. On the history of anatomo-clinical medicine, see Keele 1963; Ackerknecht 1967; Maclean 2002. On the history of clinical listening, see Jackson 1992.
2. For references from Pietro through the mid-sixteenth century, see Kümmel 1977, 32–38.
3. *Hamlet* III.iv.140–142.
4. For a general description of his work, see Kümmel 1977, 38–44.
5. Rost 1953; Lyncker 1966.
6. See Kümmel 1977, 44–47.
7. For Montpellier, see Williams 2003.
8. For Marquet’s career, see Costa 2008, 20–21.
9. Besides Herophilus, he placed his project in the lineage of “Avicenna, Savonarola, Saxon, and Fernel, and many other learned physicians of antiquity;” who proposed this connection between music and cardiac rhythm, “though unable to execute it” (Marquet 1769, 4–5). All translations are by the author, unless otherwise noted. Among the few mentions of Marquet’s work, see Kümmel 1977, 47–50, who emphasizes its relation to the strongly accented music of the time, and Kassler 1995, 220–221. There are brief descriptions in Pistacchio and Pistacchio 1996 and Grignon 1997. The most significant treatment of Marquet to date is in Sykes 2014, 60–63, which helpfully contextualizes different modalities of hearing.
10. Marquet 1769, 2–3.
11. *Ibid.*, 1.
12. *Ibid.*, 1–2.
13. *Ibid.*, 3–4.
14. Here Marquet referenced “the great [Friedrich] Hoffmann [1660–1742]”; see Duchesneau 1982, 32–64.
15. Marquet 1769, 210, referring to Duverney 1683. Regarding Duverney, see Sykes 2014, 27–37; Gouk and Sykes 2011.
16. Marquet 1769, 199–200. Marquet also applied his mechanical understanding of the body to advocate the use of music in the treatment of melancholia in his “Oration on the Twenty-Third Aphorism of Hippocrates” (delivered in 1759, the year of his death), in Marquet 1770, 198–215 at 198.
17. Note that Marquet’s first edition preceded the 1752 original publication of Quantz 1966. For discussion of issues regarding pulse measurement of tempo, see Pesic 2013. Wellmann 2017, 68, also comments on Marquet.
18. Marquet 1769, 37.
19. *Ibid.*, 15–16.
20. *Ibid.*, 36–37.
21. For instance, Quantz 1966, 283–291. For developments in the musical theory of rhythm, see Wellmann 2017, 61–75, commenting on Marquet at 68.
22. Marquet 1769, 32.
23. *Ibid.*, 32–33.
24. *Ibid.*, 33–34.
25. Vieussens 1715.
26. Cf. the assertion of Sykes 2014, 61, that Marquet’s minuet overlaid “perceived pulse sounds over the form of the dance” so that “by visualizing the *sounds* of the pulse a better diagnosis could be made.”
27. Marquet 1769, 40. I have corrected the evidently erroneous “devient rapide” to “becomes less rapid.”
28. Regarding these critical reactions, see also Kümmel 1977, 51.
29. Bordeu 1756, 451. For Bordeu’s relation to Montpellier, vitalism, and Diderot, see Williams 1994, 20–49; 2003, 147–162, 215–220. Bordeu’s commentary on Marquet is also helpfully addressed in Sykes 2014, 58–70. See also the helpful discussion in Emch-Deriaz 2001.

30. Sykes 2014, 67.
31. Its editor, Marquet's son-in-law Pierre-Joseph Buchoz included a number of encomia (including his own), but these came preponderantly from physicians from Nancy, hence part of Marquet's professional circle, perhaps his friends or those who wished to honor his memory. See Pesic 2016, 12n36. Regarding Buchoz, see Erlmann 2010, 139.
32. Marquet 1769, "Jugement de Monsieur le Baron Duhaler sur cet ouvrage" (79–81), answered by "Réponse à l'auteur anonyme, sur sa satire, Contre le Traité du Pouls" (82–83).
33. Buchoz also includes Ménuret's "Extrait du nouveau Traité du Pouls" (*ibid.*, 86–95), which largely duplicates material in "Exposition en forme de critique, de la Doctrine du Pouls par la Musique, par les Auteurs du Dictionnaire Encyclopédique, à l'article Pouls" (142–160). To Buchoz's credit, he includes the passages most critical of Marquet.
34. Much of this material also appeared soon thereafter in Ménuret's *Nouveau traité de la pouls* (1768).
35. See Williams 2003, 119–23, 226–230.
36. Ménuret de Chambaud 1751b, 13:220–221, also quoted in Marquet 1769, 144, 159.
37. Thus, for instance, Ozanam 1886, 111, after summarizing Marquet's ideas, finds that they have "no practical result and in no way advanced the semiotic sciences." I thank Martine Voiret for her expert advice on the eighteenth-century connotations of "détails pénibles."
38. Ménuret de Chambaud 1751b, 13:221–228
39. *Ibid.*, 13:225.
40. Ménuret de Chambaud 1751a, 10:903.
41. *Ibid.*, 10:904. a view he ascribes to one "dom Calmet."
42. Throughout, Ménuret cited his friend Roger 1758.
43. Ménuret de Chambaud 1751a, 907. For the connotations of "fibers" in Montequieu, see O'Neal 2002, 102–105.
44. Ménuret de Chambaud 1751a, 10:908, which mentions that his findings were "read at the Société Royal des Sciences" but does not give a date or further reference.
45. For instance, Marquet is not mentioned in Roger 1758 or in its later translation, Roger 1803.
46. Floyer 1707; Gibbs 1971, 1994. The minute hand had first appeared in watches about 1670. For the earlier history, see Levett and Agarwal 1979.
47. Porter 2001, 165–166.
48. Haller 1760, 2:171.
49. *Ibid.*, 2:182.
50. For instance, Falconer 1796, 17, cites Marquet's value of 60 for adult resting pulse as coming from Haller.
51. This point is also emphasized by Fantini 2013, which discusses Haller on 259–260.

## Chapter 9

1. Brechka 1970 discusses Van Swieten's reforms in the teaching and practice of medicine (132–142) and his interest in music (114). See also Erlmann 2010, 140–141.
2. Swieten 1754, 1:38.
3. These are discussed in *ibid.*, 1:39–97.
4. *Ibid.*, 11:478–479, sec. 1191.
5. *Ibid.*, 8:241, sec. 826.
6. Duffin 2006, 269–70, esp. 269n78.
7. Lesky 1959.
8. For convenience, I will cite from the original text and translation given in Auenbrugger 1808, xxi. See the very helpful discussions of Auenbrugger in Sterne 2003, 119–122, and Volmar 2012, 22–36.



9. Neuburger 1922, 11.
10. His only mention of casks is Auenbrugger 1808, 46–47. I will bring forward evidence confirming the suggestion that “Auenbrugger’s musical abilities may have contributed to his discovery of thoracic percussion” given in Jarcho 1961, 169. Dock 1935, 447, also thinks that Auenbrugger’s musical training “must have influenced his choice of words.”
11. This has been noted also by Schwartz 2011, 202–205.
12. For the score of the opera, see Salieri and Auenbrugger 1986. The editor’s introduction provides useful commentary on the context of the work in the development of German Singspiel. For the printed libretto, see Schwan et al. 1986. Mozart’s comment comes in his letter of December 10, 1783: Mozart 1997, 863.
13. Abert 2007, 258.
14. Glickman, n.d.
15. This work was rediscovered and included in Harbach et al. 1986.
16. Auenbrugger 1808, 2, 4.
17. Blades and Bowles, n.d.; Blades 1970, 263. Given his close association with the composer, Auenbrugger probably was aware of Salieri’s innovative use of timpani with unusual tunings in operas written in 1772 and 1785, though these postdated Auenbrugger’s clinical work of the 1750s and his ensuing 1761 publication detailing his discovery of diagnostic percussion.
18. For the relation between Corvisart and Auenbrugger’s work, see O’Neal 1998, 2002, 162–185, and Volmar 2012, 37–40.
19. Auenbrugger 1808, 4.
20. Corvisart also emphasized the tactile aspects of percussion; see McCarthy 1999.
21. For details, see Pesic 2016, 19.
22. Auenbrugger 1808, 37–42, at 41.
23. *Ibid.*, 132.
24. *Ibid.*, 133.
25. Perhaps this is the ultimate source of the famous “dog that does not bark” invoked by Sherlock Holmes, influenced by his physician-creator, Arthur Conan Doyle.
26. Auenbrugger 1808, 171–176.
27. O’Sullivan 2012. See also Starobinski 1966; Roth 1991.
28. Auenbrugger 1808, 172.
29. *Ibid.*, 178.
30. *Ibid.*
31. Among the most useful studies, see Reiser 1978, 23–44; Sterne 2003, 99–136; Duffin 1998; Volmar 2012, 38–46.
32. Duffin 1998, 17, 20, 80–82. Laennec’s musical background is also discussed insightfully by Schwartz 2011, 206–211.
33. Duffin 1998, 252.
34. *Ibid.*, 124. For Bayle, see Reiser 1978, 25.
35. Duffin 1998, 96–101, at 98.
36. *Ibid.*, 42.
37. *Ibid.*, 129.
38. Corvisart des Marets 1812, 19.
39. Jarcho 1961, 169.
40. For an insightful discussion of the growing significance of timbre in music, see Dolan 2013.
41. For the evocation of microsound in nineteenth-century music, see Brittan 2011.
42. For a detailed account of his work in cardiology, see Duffin 1989; Duffin 1998, chap. 8. For the changing practice of listening involved in auscultation, see Sterne 2003, 117–136.

43. Sterne 2003, 135–136, at 135. For a modern medical student’s thoughtful account of learning to auscultate, see Rice 2011. See also the larger perspectives discussed in Bijsterveld 2019, 11–12 (on Laennec).
44. Grmek 1981; Duffin 1998, 134–138.
45. Laennec 1826, 64.
46. *Ibid.*, 64ff.
47. *Ibid.*, 436–437. More generally about this phenomenon, see Duffin 1998, 141–144.
48. Duffin 1998, 112–113.
49. Laennec 1826, 75.
50. *Ibid.*, 743–744.
51. La Villemarqué 1867, viii (music), 120–122 (text).
52. Laennec is somewhat unclear on Erman, whom he also calls “Hermann” and identified only as secretary of the Academy in Berlin with whom he corresponded in 1820. The papers in question are Erman 1812; Wolaston 1812.
53. Laennec 1826, 746–752, at 752–753.
54. *Ibid.*, 752–753.
55. Some of Laennec’s editors saw fit to omit these coronary melodies as “mere curiosities.” For example, the notated melody was omitted with this editorial footnote in Laennec 1830, 567. Laennec’s musical description is described as “the most disarming passage in his entire opus” by Duffin 1998, 192, which also cites Cruveilhier’s reaction and discusses the reception of Laennec’s treatment of the heart on 174–206. For this and other reactions to stethoscopy, see Reiser 1978, 30–44, at 34–35.

## Chapter 10

1. See Goldstein 2001, 155–156.
2. For an overview of the phenomenology of obsession, see Davis 2008, 3–30.
3. This work was identified as a precursor of Hector Berlioz’s use of *idée fixe* by Brittan 2006, who acknowledged Ralph Locke for this information (214n14).
4. The most detailed treatment to date is Howe 2017. See also Georgallas 2016, whom I thank for kindly sending me a copy of this unpublished presentation and of the Piquer *Discorso*.
5. For a historical overview of these clinical categories, see Kümmel 1977, 277–287.
6. Hunter and Macalpine 1963, 27.
7. *Ibid.*, 27–28.
8. *Ibid.*, 28.
9. See, for instance, *ibid.*, 377–378.
10. *Ibid.*, 187. See Eadie 2003a, 2003b.
11. Hunter and Macalpine 1963, 187. See Willis 1674. “Mania” was translated as “madness” in Willis 1683.
12. Willis 1683, 193.
13. *Ibid.*, 201.
14. Hunter and Macalpine 1963, 163. See the historical survey in Berrios 1996, 140–156, at 140–141.
15. Berrios 1996, 142.
16. *Ibid.*, 141.
17. For an overview of these developments, see Davis 2008, 32–54.
18. “Yo fui loco, y ya soy cuerdo”; Cervantes 1979, 668. See Cejador y Frauca 1905, 695.
19. For obsession in other literary works, see Davis 2008, 54–65.
20. Cervantes 1979, 147.

21. For the details of these changes, see Pestic 2019, 69–70.
22. Kamen 2001, 121–124, 159–160, 162–163, 178–179, 189–191. For the larger context of Felipe V’s disordered predecessor, Carlos II, see Green 1993, 153–175.
23. For his frog delusion, see Kamen 2001, 165.
24. Coxe 1813, 3:89.
25. Kamen 2001, 200–202; Green 1993, 173; Kirkpatrick 1953, 94–106.
26. See Kirkpatrick 1953, 87–92, 107–136.
27. Piquer 1759, as translated in Pérez et al. 2011, which gives a helpful analysis of Piquer’s work.
28. His later textbook (Piquer 1764, 94–95) cites Willis’s *De febribus* (1659) but not Willis’s work on mental conditions, which he does not seem to have known.
29. According to Pérez et al. 2011, 73, 74.
30. Petrie 1971, 3, 229.
31. For his melancholy, see Hargreaves-Mawdsley 1979, 100. For his remark to the ambassador, see Petrie 1971, 228, 164–165.
32. Petrie 1971, 164–165.
33. For the larger context, see Ullersperger 1871; Alvarez and Winston 1991.
34. Petrie 1971, 223–224. As king, Carlos IV was “good-hearted but weak and simple-minded . . . vacillating and confused,” his “ineptitude” leading directly to the fall of the Bourbon dynasty and the Napoleonic takeover in 1808, according to Payne 1973, 415–416, 420.
35. Petrie 1971, 226–227.
36. *Ibid.*, 224.
37. Belgray 1970, 20.
38. Ruiz Casaux y López de Carvajal 1959, 16, cited and translated in Belgray 1970, 26.
39. *Ibid.*, 83.
40. *Ibid.*, 87–88, 93.
41. *Ibid.*, 320.
42. Lynch 1989, 294.
43. *Ibid.*, 295.
44. Newell Jenkins rediscovered and recorded it, published as Brunetti 1960.
45. See Head 2014.
46. See Ramos 1997, 304–318.
47. The immediate cause seems to be the semitone E-flat–D in the first violins (m. 20), but the Largo had ended with an extended G–F# trill in the first oboe (mm. 17–19).
48. Iriarte 1779, 9, 40, as translated in Iriarte 1807, 48.
49. Piquer 1764.
50. As argued by Georgallas 2016.
51. Belgray 1970, xvi–xvii.
52. *Ibid.*, xvii.
53. See Ivanovich 2014.
54. Though this reprise closely follows the original Andantino, it ends on the dominant of C rather than the original dominant of E-flat.
55. *Ibid.* This is the first time the symphony has moved away from E-flat and C minor, though only so far as to its parallel major.
56. Belgray 1970, 97–105, points out that several accounts of the enmity between Boccherini and Brunetti lack any documentary foundation so that “it is difficult to fathom the origin or determine the truth of the story.”

57. Rothschild 1965, 39–40. The translation has been slightly adjusted to follow the orthography of the Spanish original, given in Solar-Quintes 1947.
58. Rothschild 1965, 40, however without giving further evidence for this assertion.
59. Belgray 1970, 103.
60. Rasch 2014, 291.
61. This is the candidate of Gérard 1969, 346, though Le Guin 2006, 69, judges that “the quintet referred to here cannot be identified.”
62. Cf. Howe 2017; Georgallas 2016 reads the symphony in terms of mania-melancholia as bipolar disorder.
63. Cervantes 1979, 614.
64. See Durán 2006.
65. Esquirol 1838, 2:28–29.
66. For details of the evolving concepts of *idée fixe* and monomania, see Pesic 2019.

## Chapter 11

1. See Gouk 2000a, 2004.
2. Kramer 2000; Gouk 2000b.
3. For a survey of Mesmer’s career, see Gauld 1992, 1–22. For a helpful compilation of the vast literature on Mesmer, see Crabtree and Wozniak 1988.
4. Mesmer 1980, 5.
5. Cf. Pattie 1956.
6. Riskin 2002, 198.
7. See Pesic 2014a. For insightful treatment of the wider context of musical glasses, see Wolf 2015; Howard 2017, 31n32.
8. For the organological context of the harmonica, see Dolan 2013, 61–65.
9. Letter of July 13, 1762, to Giambatista Beccaria in Franklin 1959, 10:116–130.
10. Wolf 2015, 129, 114, 126.
11. *Ibid.*, 118–119, quoting a poem by a fellow Philadelphian, Nathaniel Evans.
12. For two examples, see King 1945, 100, 118.
13. Chateaubriand 1932, 111.
14. Lipowski 1984.
15. Matthews 1975. For the female associations of this instrument, see Hoffmann 1991, 113–132, and Hadlock 2000. See also Zeitler 2013, 189–204.
16. For Nissen’s view, see Abert 2007, 97n57, 58.
17. Walmsley 1967, 49.
18. According to Abert 2007, 1205–1206, the motet was written on June 17, 1791, the quintet K617 before May 23, 1791 (when Mozart entered it into his personal catalogue), and “probably also” the solo harmonica piece K356/617a (1205). See also Schmidt 2003.
19. Note, for instance the characteristic melodic gesture  $\hat{5}-(\hat{4}\#)-\hat{4}-\hat{3}$  in both works, as well as prominent use of subdominant (plagal) harmonies.
20. For his search for the voice of “his goddess” “dans les frémissement d’une harpe, dans les sons veloutés ou liquides d’un cor ou d’un harmonica,” see Chateaubriand 1981, 1:95.
21. Rochlitz 1798, 97–98.
22. Pace 1958, 280. For connections between music and electricity, see Pesic 2014b, 181–215, and Smith 2016, 150–156.
23. Wolf 2015, 125.

24. Rochlitz 1798, 101–102; King, n.d. See also Zeitler 2013, 240–243.
25. Mesmer 1980, 18; Bonuzzi 2007, 46.
26. See Walmsley 1967, 51–59.
27. Walmsley 1967, 82–91; Fürst 2005; for Mesmer’s account of the case, see Mesmer 1980, 58–65, 71–76. The spelling “Paradies” is also found.
28. King 1945, 110.
29. Ibid.
30. See Hadlock 2000, 528–532.
31. The image of the magnetic chain describing the transmission of poetic and musical inspiration goes back to Plato, *Ion* 533d–e, 535e–536c (Plato 1997, 941, 943–944).
32. Buranelli 1975, 125–126.
33. Pattie 1994, 73.
34. D’Eslon 1780, 90.
35. As judged by Hadlock 2000, 508.
36. Darnton 1968, 40.
37. Mesmer 1980, 67–68.
38. Franklin 1785, 24.
39. Darnton 1968, 151–152.
40. For “critical sleep,” see Mesmer 1980, 112, 122–126.
41. Ibid., 103. His statement recalls the general form of Hooke’s Law discussed in chapter 7.
42. See Gensini and Conti 2004; Wittern 1989.
43. See Mesmer 1980, 104–105.
44. D’Eslon 1780, 36–37.
45. Ratner 1985, 48–51.
46. Rosen 1998, 57.
47. See Hoyt 1996, which cites the use of *noeud* as term of dramaturgy on 150n32.
48. Darnton 1968, 143. Capitalization in the original.

## Chapter 12

1. For instance, see Binet and Féré 1888; Braid 1899.
2. For an overview of Puysegur’s career, see Gauld 1992, 39–52.
3. Puysegur 1820, 80.
4. Ibid., 50.
5. Ibid., 269.
6. Ibid., 165.
7. Ibid., 165–166. A *plateau électrique* was a small round piece of glass electrified by friction.
8. Richet 1884, 543.
9. Ibid., 200. For an overview of Richet and Charcot, see Gauld 1992, 297–317.
10. Harrington 1985.
11. Claretie 1881, 126. See Didi-Huberman 2003; Arnaud 2015.
12. For Donezetti’s original version, see Donizetti 1941, 151r–165v. For a discussion of the change of instrumentation, see Hadlock 2000, 534–535, and Gossett 2006, 434–435. See also Sala 1994, 40.
13. Ashbrook 1965, 416–417.

14. Hadlock 2000, 534. For an insightful discussion of the reception history of this scene and its medical context, see Pottinger 2020.
15. This cadenza is generally interpolated at 4 bars before rehearsal number 32 in act III, number 14, according to Pugliese 2004. For the accompanied version, see Warner Classics 2014. For the unaccompanied cadenza, see Serban n.d.
16. Pugliese 2004, 35–37, at 37.
17. For Richet’s influence, see Ellenberger 1970, 90; Bogousslavsky 2011, 200. For Charcot’s study of magnetism-inducing metals, see Harrington 1988. For the roles of the women patients, see Borgstrom 2000.
18. Charcot 1882, 403, characterizes this type of hypnotism as “its type of perfect development,” echoing the language of Puységur’s *crise magnétique complète*.
19. For the use of the tam-tam in Charcot’s clinics, see Richer 1881, 401, 600; Hustvedt 2011, 78, 196–199; Didi-Huberman 2003, 208–210.
20. Raz n.d.
21. Bourneville and Régnard 1879, 178–181.
22. *Ibid.*, 179–180.
23. Claretie 1881, 129, who tells another such story of inadvertent catalepsy induced by cymbals on 128.
24. See Blades 1992, 382–385. For a comprehensive survey of the instrument’s history, see Kreuzer 2018, 109–161.
25. Amiot 1827, 366. Amiot goes on to describe the forging of such a *lo* in detail. Because he describes tuning the newly forged *lo* against another an octave apart, one wonders whether he is describing a pitched gong. In a 1786 letter, Amiot mentions the “*yun-lo* commonly called ‘tam-tam’”; see Hermans 2005, 56n212. For the science of fabricating tam-tams, see Kreuzer 2018, 135.
26. *Ibid.*, 135.
27. Monelle 2006, 126.
28. *Ibid.*
29. Kreuzer 2018, 119.
30. See Tiersot 1908, 52–53, 56, 58–59, 212–213.
31. Martin 1868, 3:460. See also Johnson 1996, 139–140.
32. As given in Tiersot 1908, 52, 274; the *Moniteur* citation is from April 6, 1791.
33. As noted in *ibid.*, 58. Here *timbre* may also refer to a “convex metal disc” or cymbal, from the Greek *tymbanon*, perhaps cognate with “clanging cymbal [κύμβαλον ἀλαλάζον]” in Paul’s celebrated passage (1 Corinthians 13: 1). Chénier’s poem “Du pouvoir de la musique” was dedicated to the operatic composer Étienne Méhul, at whose funeral Gossec’s march was also played; see Monelle 2006, 129.
34. For the history of French orientalism, see McCabe 2008.
35. Fage 1844, 211. This was presumably the tam-tam Amiot sent to the duc de Chaulnes.
36. Berlioz 2002, 286.
37. Berlioz’s *March funèbre pour la dernière scène d’Hamlet* Op. 18 no. 3, H103 (1848) used a tam-tam crescendo to fortissimo to underline the chorus’s outcry “Ah!” (at rehearsal number 5), while soldiers in an off-stage platoon fire gun volleys in salute. To augment the shock from the sudden cutoff of this tremendous din, Berlioz directs the tam-tam to damp its sound abruptly.
38. See Kreuzer 2018, 135.
39. Hibberd 2004, 120, 119.
40. See Cardwell 1983.
41. See Devoto 1995; Bass 2001.
42. Cooper 1951, 56. For Richard Wagner’s ambivalent relation to the tam-tam, see Kreuzer 2018, 142–151.
43. Charcot 1890, 17; Hustvedt 2011, 97.
44. See Ellenberger 1970, 96–101; Shorter 2008, 166–200.

45. Harrington 1985, 240.
46. Babinski 1901.
47. Hoffmann 2003, 164, which refers directly to the writings of Johann Ritter (see note 15 above). For Hoffmann's relation to mesmerism, see Ellenberger 1970, 159–162; Willis 2006, 28–82; Smith 2016.
48. Hoffmann 2014.
49. Radau 1869, 273; Kreuzer 2018, 142.
50. Freud 1966, 13.
51. Ellenberger 1970, 150, considers mesmeric crisis to be “a variety of what we call today the cathartic therapy.”
52. Bernays 1880; Dalma 1963; Ellenberger 1970, 484.
53. Freud 1966, 28.
54. Freud 1963, 80–81.

### Chapter 13

1. Mersenne 1963, 2. I thank Schwartz 2011, 96–97, for bringing this and the following citations of Hooke to my attention.
2. Hooke 1705, 39. For the dating of this work, see Hesse 1966, 68.
3. Hooke 1705, 39.
4. *Ibid.*
5. *Ibid.*, 40.
6. Schwartz 2011, 97.
7. Hooke 1705, 135.
8. See Findlen 2013.
9. Spallanzani and Vassalli 1794.
10. The translation is included in Galambos 1941, here cited from an unpublished manuscript, Spallanzani 1941.
11. *Ibid.*, 4.
12. *Ibid.*, 11–14.
13. *Ibid.*, 17.
14. *Ibid.*, 23.
15. Jurine 1798, 139, a translation of Peschier 1798. Jurine's original memoir of 1794 was never published and seems lost, according to Dijkgraaf 1960, 9.
16. Jurine 1798, 140.
17. Galambos 1942, 135, quoting Jean Senebier's 1799 account of Spallanzani's later views.
18. *Ibid.*, 136–137.
19. Cited in *ibid.*, 137.
20. Whitaker 1906, 149, 147.
21. Hahn 1908, 191.
22. Maxim 1912, 148.
23. *Ibid.*
24. *Ibid.*, 150.
25. For the early history of sonar, see Ainslie 2010, 6–15; for a comprehensive history through the 1960s, see Hackmann 1984. For Richardson, see S. A. Richardson 1957, 303. His patents are L. F. Richardson 1913a, 1913b.

26. See the fascinating account in Trippett 2018, 202–206.
27. L. F. Richardson 1913a, 3. Above water, he used a “bird call” sounding frequencies near 10,000 Hertz.
28. See Merklinger and Ellis 2017 and Hackmann 1984, 74–75.
29. As predicted by Gabriel Lippmann and observed by the Curies in 1881.
30. “Asdic” was the preferred British term (from “Anti-Submarine Division”), “sonar” the American coinage (“Sound Navigation and Ranging”). For the history of these terms, see Hackmann 1984, xxv–xxvi, which discusses Curie’s work on 77–89.
31. *Ibid.*, 81–82.
32. Hartridge 1920, 56. For his career, see “H. Hartridge MD” 1976.
33. I have followed the account of Page 1962, 20–25.
34. *Ibid.*, 25–26.
35. Griffin 1958, 66.
36. *Ibid.*, 67.
37. *Ibid.*, 69.
38. As estimated by Belrose 2002.
39. As he described it in Tartini 1754, translated in Johnson 1985. For the history, see Jones 1935. For an insightful discussion in the context of Tartini’s conception of nature, see Polzonetti 2001, 14–22.
40. See, for instance, Chung 2018.
41. For a careful discussion of the subtleties and controversies surrounding these phantoms, see Heller 2012, 493–504, addressing Tartini tones at 499–501.
42. Fessenden 1902, 2.
43. Hogan 1999, 1981–1982, a reprint of the 1913 original of that paper.
44. Helmholtz 1924, 2:66.
45. Nagel 1974, 438. See Chua and Rehding 2021, 173–174, for an interesting response.

## Chapter 14

1. Kittler 1999, xli; see also Winthrop-Young 2002.
2. Nicolson and Fleming 2013, 15–16.
3. *Ibid.*, 15–19, at 17.
4. *Ibid.*, 18.
5. *Ibid.*, 18, 28.
6. *Ibid.*, 19–21.
7. Cited in *ibid.*, 19.
8. *Ibid.*, 15.
9. *Ibid.*, 21.
10. *Ibid.*, 21–22; White 1948.
11. White 1948, 45.
12. Nicolson and Fleming 2013, 32–35.
13. For PPI, see *ibid.*, 23.
14. *Ibid.*, 35–45, at 47.
15. *Ibid.*, 39.
16. Cited in *ibid.*, 49.
17. For the larger dimensions of this connection with childhood illness or injury, see Roe 1953.



18. Regarding this milieu, see Nicolson and Fleming 2013, 42–50.
19. See Donald 1974, 109.
20. Nicolson and Fleming 2013, 90–91.
21. *Ibid.*, 109–110.
22. Donald 1974, 110.
23. For a detailed account of this reenactment, see Nicolson and Fleming 2013, 92–98, at 97–98.
24. *Ibid.*, 98.
25. *Ibid.*, 102.
26. *Ibid.*, 111.
27. Donald 1974, 111.
28. *Ibid.*
29. Nicolson and Fleming 2013, 114.
30. *Ibid.*, 115. For its early development, see Singh and Goyal 2007.
31. Donald, MacVicar, and Brown 1958, 1193–1194.
32. Cited in Nicolson and Fleming 2013, 117.
33. *Ibid.*, 120.
34. *Ibid.*, 124.
35. *Ibid.*, 123.
36. *Ibid.*, 124–125.
37. *Ibid.*, 135.
38. *Ibid.*, 206.
39. *Ibid.*, 206–207, 220.
40. *Ibid.*, 231.
41. *Ibid.*, 194–195.
42. *Ibid.*, 231.
43. *Ibid.*, 233. See also Singh and Goyal 2007.
44. See Linebarger et al. 1999; Brannen and Bush 1984.

## Chapter 15

1. See above, chapter 7, and Wallace 2003.
2. Gouk 2014, 44. Among more extensive studies, see, for instance, Rousseau 2004; Vila 1998; Lawrence 1979.
3. Gouk 2014, 46. Hartley calls this substance “isochronous,” meaning that its vibrations occur in equal times like those of a string.
4. *Ibid.*, 47.
5. As recounted in Wiltshire 2019; Eliot 1962, 20.
6. For this history, see McComas 2011, 11–20.
7. See Pesic 2014, 185–195.
8. *Ibid.*, 190.
9. Müller 1838, 819–820, emphasis in the original.
10. Bell 1833, 21.
11. See Crary 1992, 89–90, and Jay 1993.
12. Sterne 2003, 55, giving a helpful overview of Müller on 60–62.

13. As rendered by Erlmann 2010, 205–206, who gives an insightful treatment of Müller on 202–216.
14. *Ibid.*, 208.
15. As noted by *ibid.*, 202–203.
16. Sterne 2003, 62.
17. Müller 1838, 673–674.
18. For this history, see McComas 2011, 11–27.
19. Finkelstein 2003, 2015.
20. For this phase of his work, see Olesko and Holmes 1994.
21. Koenigsberger 1965, 65.
22. For the larger context, see Canales 2009.
23. Piccolino and Bresadola 2013, 276. For a detailed account of this apparatus and Helmholtz’s work with it, see Schmidgen and Schott 2014, 55–84, as well as Olesko and Holmes 1994, 68–69.
24. Helmholtz 1954, 122.
25. See Michelson 1880, 121–122.
26. Kleppner 2007, 8.
27. *Ibid.* and Michelson 1880, 120.
28. Harry 1987. See especially Wise 1997, 200–213.
29. See Helmholtz 1855 in Helmholtz 1882, 2:881–885, and the discussion in Olesko and Holmes 1994, 74–82.
30. Helmholtz 1954, 20.
31. For the larger context of these phonetic investigations, see Brain 2015, 64–92.
32. Koenigsberger 1965, 158.
33. Helmholtz 1954, 129.
34. Pantalony 2004.
35. See Pantalony 2009.
36. Cited from *ibid.*, 428. See also Vogel 1993, 269.
37. Wollaston 1810, 9.
38. Erman 1812, 21–22; in fact, Wollaston’s paper appeared in German translation in the same issue as Wollaston 1812.
39. Wollaston 1810, 2.
40. For the context of his contemporary work, see Cahan 2018, 319.
41. For the larger meanings of these words, see Erlmann 2010, 166–168.
42. Haughton 1863, 3.
43. Helmholtz 1864 in Helmholtz 1882, 2:924–927, at 925, translated in this book’s appendix.
44. *Ibid.*
45. Helmholtz 1866 in Helmholtz 1882, 2:928–931, translated in this book’s appendix. For the relation between *tonus* and tone, see Erlmann 2010, 128–129.
46. See Lenoir 1986, 28.
47. *Ibid.*, 33. See Bernstein 1894, 131–132.
48. For a good overview of his work, see Lenoir 1986, 39–47.

## Chapter 16

1. My account in this chapter relies on Volmar 2015, 60–80, quoted here on 85, as well as Dombois 2006. Because Volmar 2015 is (at this writing) available only in German, I recount a number of his detailed findings to make them more widely accessible.

2. du Bois-Reymond 1877, 575–576, as discussed in Volmar 2015, 62.
3. Ibid., 573, citing the work of R. Grossman he discussed in du Bois-Reymond 1875, 1:170.
4. Bernstein 1878, 123; Volmar 2015, 70.
5. Hermann 1878, 504.
6. Volmar 2015, 67.
7. d'Arsonval 1878, 832.
8. Ibid., 833; emphasis in the original.
9. Tarchanow 1878, 353, who subsequently described the greater sensitivity achievable with the Siemens and Halske telephones in Tarchanow 1879. Volmar uses the contemporary romanization Tarchanov.
10. Tarchanow 1878, 353–354.
11. Volmar 2015, 68.
12. For these developments of binaural listening, see Sterne 2003, 111–113, 155–156.
13. Bernstein 1881, 19.
14. Ibid., 22.
15. Cahan 2018, 576.
16. Stirling 1888, 156, who used tuning forks in many of his demonstrations; see 162, 171–173, 238, 241, 262, 301. See Volmar 2015, 62–63.
17. For these developments, see Volmar 2015, 66–80.
18. Sanderson 1895, 143.
19. Wedensky 1900, 139, emphasis original; for his work, see Volmar 2015, 73–76.
20. Wedensky 1900, 189, as noted by Volmar 2015, 80.
21. Wedensky 1883, 315.
22. Wedensky 1900, 144–145, emphasis original.
23. Snellen 1994.
24. Höber 1919, 305.
25. Ibid., 306.
26. Ibid., 309.
27. Ibid., 310–312, listing also work by Bernstein and others who applied their sonic findings to clinical studies.
28. Ibid., 312. For an insightful discussion of the microphonic amplification of “small sounds,” see Abbate 2016, 806–820.
29. See, for instance, Cabot 1923 and the references in Scheminzky 1927, 500–501.
30. See the helpful commentary in Volmar 2015, 84.
31. Scheminzky 1927, 483.
32. Ibid., 498.
33. The term *soundscape* was introduced by Schafer 1993.

## Chapter 17

1. For an excellent overview, see Finger 2000, 239–258.
2. Gotch and Horsley 1888, 19.
3. Ibid., 20.
4. See Lippmann 1875; Stock 2004.
5. McComas 2011, 63–64.
6. Lucas 1905, 125.

7. Lucas 1909, 8.
8. *Ibid.*, 118–119.
9. *Ibid.*, 133.
10. See the excellent treatment by Frank 1994.
11. *Ibid.*, 128.
12. As noted by Erlanger and Gasser 1937, 2.
13. See Garten 1910, 553.
14. For the working conditions, see Hodgkin 1979, 13. McComas 2011, 64–67, discusses the early work of Adrian and Lucas.
15. Adrian 1932, 2.
16. Regarding the vibration problems, see Forbes and Thacher 1920, 458–463.
17. Gasser and Erlanger 1922, 501. For the estimate of the natural frequency, see Erlanger and Gasser 1937, 3.
18. Adrian 1921.
19. *Ibid.*, 194.
20. Adrian and Lucas 1912.
21. *Ibid.*, 218–224.
22. Cited in Frank 1994, 226.
23. Adrian and Forbes 1922, which included both afferent and efferent nerves and used a string galvanometer.
24. For this history, see McComas 2011, 98–100.
25. Here I am following the account of Frank 1994, 227.
26. Adrian et al. 1954, 17.
27. Adrian 1926, 49.
28. *Ibid.*, 40; see Lucas 1912.
29. Between September 1924 and July 1925, according to Hodgkin 1979, 28, Adrian was led to this experiment by reports of electrical impulses reported by Forbes, Campbell, and Williams 1924.
30. According to his 1954 recollections in Adrian et al. 1954, 17. See OED s.v. “microphonic” A.2.b: “Designating, relating to, or vulnerable to unwanted noise or modulation produced in electrical equipment by vibration,” giving examples dating from 1919.
31. Adrian et al. 1954, 18.
32. Adrian 1926.
33. *Ibid.*, 64.
34. Adrian and Zotterman 1926, 156.
35. Hodgkin 1979, 30.
36. Adrian 1928, 118–119.
37. Adrian and Matthews 1927, 379.
38. See Hodgkin 1979, 31–33.
39. *Ibid.*, 65n76.
40. *Ibid.*, 31. For the summary of their work, see Adrian and Matthews 1927, 410–411.
41. See the summary in Adrian and Matthews 1927, 300–301.
42. On this point, Hodgkin 1979, 65n76, says only that Adrian and Rachel Matthews “had previously listened for impulses.”
43. Cooper and Adrian 1924.
44. If they had been working with cephalopods, the optic nerve frequencies would have been higher—around 30–90 Hertz; for these frequencies. See Adrian and Matthews 1928, 276.
45. *Ibid.*, 274.

46. *Ibid.*, 297.
47. *Ibid.*
48. Hodgkin 1979, 5.
49. See Pollitt 1972, 54–60, at 58.
50. Hodgkin 1979, 33.
51. Adrian and Bronk 1929, 145.
52. Adrian and Bronk 1928, 84.
53. *Ibid.*, 83.
54. *Ibid.*, 84.
55. For the larger context of loudspeakers, see Schwartz 2011, 626–637.
56. See Thompson 2002, 239–241, at 240.
57. *Ibid.*, 241.
58. Devlin 2018, 18–19.
59. Sterne 2003, 137.
60. Hodgkin 1979, 33.
61. B. H. Matthews 1928, 227.
62. See B. H. Matthews 1928; B. H. C. Matthews 1929; assessed by Hodgkin 1979, 35, and Gray 1990, 267. This device was sometimes also called an “oscilloscope” in contemporary sources, but to avoid confusion with the cathode ray device, I have used Matthews’s original name.
63. Adrian and Bronk 1929.
64. *Ibid.*, 120.
65. *Ibid.*, 131, 141.
66. See the description and discussion in Hodgkin 1979, 132–134.
67. *Ibid.*, 34, also notes Adrian’s skill in roof climbing and fencing (8).
68. Adrian and Bronk 1929, 135n1.
69. *Ibid.*, 135, cueing the note just cited after “loud speaker.”
70. “The Nobel Prize in Physiology or Medicine 1932,” n.d.a.
71. For the references to “gramophone records,” see the note appended to *ibid.* I thank many people at the Nobel Foundation, Karolinska Institutet, Trinity College Library, as well as Roger Keynes, Hugh Matthews, and Tilli Tansey for their efforts to find these recordings; I continue to hope that someday they will be found and heard again. For recording in medicine, see also Bijsterveld 2019, 98–99.

## Chapter 18

1. Chua and Rehding 2021, 86–94, give a striking exploration of this idea.
2. Feld 2003, 224; see also Rice and Feld 2020.
3. See, for instance, Bijsterveld 2019, 6.
4. For instance, Helmholtz 1954, 149. See Otis 2001, 2002.
5. Adrian 1930, 339.
6. Garson 2015, 33; 2003.
7. Gamma (30–100 Hertz) and delta (around 4) waves were identified later. For Berger’s discovery and its context, see Pesic 2017, 248–250.
8. For their statement clarifying Berger’s priority, see Adrian and Matthews 1934. See also McComas 2011, 109–111.
9. Adrian and Matthews 1934a, 443.

10. Adrian and Matthews 1934b, 357.
11. *Ibid.*, 382.
12. Adrian 1941, 160.
13. See *ibid.*, 166, 171, 173–174, 182–183, 188.
14. *Ibid.*, 173, 186–187, 189–191. See also Garson 2015, 32–33, 40, 42, 44, who connects signals with larger historical contexts, as does Schwartz 2011, 647–649, 836–837.
15. Quoted from Sterne 2003, 260; see also Volmar 2018.
16. Adrian and Umrath 1929, 142. The comment about Adrian’s attitude to the oscillograph comes from Pfaffmann 2012, 334.
17. Adrian and Ludwig 1938, 444.
18. Adrian 1942, 460.
19. Adrian 1947, 23–24.
20. *Ibid.*, 22–23.
21. *Ibid.*, 23–24.
22. Nietzsche 1997, 143, aphorism 250.
23. Daston and Galison 2007, 372.
24. For instance, Hubel 1959; Hubel and Wiesel 1959, which was reissued as Robertson 2009. For a fuller account of their collaboration, see Hubel and Wiesel 2005, which mentions audio monitoring on 60–61; Hubel et al. 2015 revisits their early work and adds new information.
25. This and all other quotes from Conway come from email commentary he sent me in December 2020, for which I am most grateful.
26. Hubel 1982, 28.
27. Hubel 1958.
28. This comment is from a film commentary Hubel made for a reenactment of *Hubel and Wiesel Cat Experiment* n.d., 01”–26”.
29. “The Nobel Prize in Physiology or Medicine 1981,” n.d.b. (video), 7’40”–8’23”. Note that his comments in the video version were sometimes more extensive and slightly different from the printed text.
30. Hubel 1982, 27–28. Conway notes that the time line for these experiments (“a month”) is not accurate, based on his examination of the records.
31. *Ibid.*, 28.
32. Hooke 1705, 8.
33. Debru 2001, 475; Schwartz 2011, 323–324.
34. Daston and Galison 2007, 314.
35. *Ibid.*, 363. It should be added that they go on to discuss twenty-first-century experiments in which “seeing is action” because the acts of vision in those cases actually change or bring into existence the phenomena in question, such as in nanotechnology.
36. For the brain/computer analogy, see Pesic 2017, 251–268.
37. See Heller 2012, 87–88, at 87.
38. See Pesic 2014, 125–130, 156–157, 174, 222.
39. See above chapter 13 and figure 13.5.
40. Various proposals for “color harmony” connect 3:2 ratio in light frequency (for instance) with the “harmony” of those hues, but the sheer number and differences between such attempts indicate that they are far more problematic than the Pythagorean connections of ratio and consonance.
41. Regarding sonification, see Kramer 1994; Kramer et al. 1999; 2010; Hermann, Hunt, and Neuhoff 2011; Supper 2012; Sterne and Akiyama 2012; Grond and Hermann 2012; Schoon and Volmar 2012; Volmar 2013a 2013b; Dubus and Bresin 2013; Pesic and Volmar 2014; Morat and Volmar 2017; Bijsterveld 2019.
42. Nagel 1974, discussed above at the end of chapter 13.

## Chapter 19

1. Brookhart, Moruzzi, and Snider 1950, 466.
2. McComas 2011, 100, does mention that “Adrian could also listen to” the nerve impulses via earphones or loudspeaker.
3. All quotations are from the author’s interview with Leslie Kay on February 27, 2020.
4. See Pauletto and Hunt 2006; Crisp 2018.
5. See Kinney and Prass 1986.
6. See, for instance, Benazzouzz et al. 2002. My special thanks to Creig Hoyt and to Beate Diehl, who kindly directed me to the work of Alim-Louis Benabid, of which this is an example.
7. I thank Ari Winnick for pointing out these examples and their ubiquity.
8. See Tavel 1996; Rice 2011.
9. See Zühlke, Myer, and Mayosi 2012.
10. See Gordon and Lagerwerff 1976; Tavakolian et al. 2011; Shams, Zuckerwar, and Dimarcantonio 2016.
11. Movahed and Ebrahimi 2007.
12. McLaren et al. 1975.
13. Mahnke 2009; Viviers et al. 2017.
14. See McNeil 2019.
15. Duverney 1683, 201–202, as translated in Duverney 1737, 141, brought to my attention by Schwartz 2011, 98–99.
16. Gold 1948. For his detailed personal account, see Gold 2012, 49–58.
17. Kemp 1978.
18. See “Newborn and Infant Hearing Screening” 2010, 15, 26.
19. Temple 2017.
20. Turing 1950, 24.
21. The website is Temple n.d.
22. Temple 2017, 9.
23. Temple 2020.
24. Sterne 2003, 16.
25. Temple 2020.
26. Regarding the gramophone, see Kittler 1999. For the relation between media theory and music theory, see Chua and Rehding 2021, 31–33.
27. See Rehding 2018.
28. According to Anonymous 2018.
29. Email communication, February 27, 2021.
30. Ibid.
31. Parvizi et al. 2018.
32. See Hobbs et al. 2018.
33. Gibbs and Gibbs 1951, 1:131, as discussed by Daston and Galison 2007, 328.
34. For the patents, see Chafe and Parvizi 2013a, 2013b, 2014.
35. Mathews 1963, 553.
36. See Chowning 1977; 2008, 3.
37. Chowning 2008, 5. For a detailed analysis, see Meneghini 2007.
38. “Sonification” n.d.

39. Pestic 2017.

40. Helmholtz 1954, 308. For Helmholtz, see Hui 2013b, 59, 87. I thank Carl Hubel for his recollections of his father’s musical interests.

41. Ovid, *Metamorphoses* 15:63–64: “quae Natura negabat / visibus humanis, oculis ea pectoris hausit.”

## Appendix

[The originals of these two papers are Helmholtz 1864 and 1866, here following the reprinted text and pagination in Helmholtz 1882, 2:924–927, 928–931. Editorial comments are in brackets.]

1. [I have tried to render Helmholtz’s *Ton* consistently as “tone,” except where the context (such as here) clearly demanded “pitch” (*Tonhöhe*).]
2. “Outlines of a new theory of muscular action, being a thesis read for the degree of Doctor in Medicine etc.” London 1863. [Haughton 1863.]
3. [The initial phase of vibration in which the spring (or fork) is beginning to move away from its equilibrium position; contrariwise, closing beats (*Schliessungsschläge*) return to that position.]
4. [Note Helmholtz’s shift in terminology from “noise” (*Geräusch*) to “tone” (*Ton*).]
5. [By “tetanus,” Helmholtz means not the disease but the condition of strong muscular contractions or spasms—in this case secondary because caused externally by the current.]



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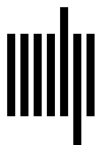
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