

Notes

Preface: Our Common Humanity

1. C. Mackay, *Extraordinary Popular Delusions and the Madness of Crowds* (1841; New York: Farrar, Straus and Giroux, 1932), p. xx.
2. People's Republic of Bangladesh Const. part III, sect. 37; Canadian Charter of Rights and Freedoms sect. 2; Republic of Hungary Const. art. LXIII; Indian Const. art. XIX (1) (b).
3. See, for example, C. Andris, D. Lee, M. J. Hamilton, M. Martino, C. E. Gunning, and J. A. Selden, "The Rise of Partisanship and Super-Cooperators in the U.S. House of Representatives," *PLOS ONE* 10 (2015): e0123507; and E. Saez, "Striking It Richer: The Evolution of Top Incomes in the United States (Updated with 2013 Preliminary Estimates)" (unpublished manuscript, January 25, 2015), <https://eml.berkeley.edu/~saez/saez-UStopincomes-2013.pdf>.
4. K. E. Steinhauser, N. A. Christakis, E. C. Clipp, M. McNeilly, L. McIntyre, and J. A. Tulsky, "Factors Considered Important at the End of Life by Patients, Family, Physicians, and Other Care Providers," *JAMA* 284 (2000): 2476–2482.
5. M. V. Llosa, "The Culture of Liberty," *Foreign Policy*, November 20, 2009, <http://foreignpolicy.com/2009/11/20/the-culture-of-liberty/>.
6. Darrell Powers, interview, *Band of Brothers*, episode 9, "Why We Fight," first aired October 28, 2001, on HBO.
7. *The Vietnam War*, episode 4, "'Resolve' (January 1966–June 1967)," a film by Ken Burns and Lynn Novick, first aired September 20, 2017, on PBS.

Chapter I: The Society Within Us

1. M. Fortes, *Social and Psychological Aspects of Education in Taleland* (London: Oxford University Press, 1938), p. 44.
2. M. Martini, "Peer Interactions in Polynesia: A View from the Marquesas," in J. L. Roopnarine, J. E. Johnson, and F. H. Hoper, eds., *Children's Play in Diverse Cultures*, pp. 73–103 (Albany: State University of New York Press, 1994), p. 74.
3. B. Whiting, J. Whiting, and R. Longabaugh, *Children of Six Cultures: A Psycho-Cultural Analysis* (Cambridge, MA: Harvard University Press, 1975). See also C. P. Edwards, "Children's Play in Cross-Cultural Perspective: A New Look at the Six Culture Study,"

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- in F. F. McMahon, D. E. Lytle, and B. Sutton-Smith, eds., *Play: An Interdisciplinary Synthesis* (Lanham, MD: University Press of America, 2005), pp. 81–96; and D. F. Lancy, *The Anthropology of Childhood: Cherubs, Chattel, and Changelings* (Cambridge: Cambridge University Press, 2008). See also E. Christakis, *The Importance of Being Little: What Preschoolers Really Need from Grownups* (New York: Viking, 2016).
4. J. Huizinga, *Homo Ludens: A Study of the Play Element in Culture* (Boston: Beacon Press, 1950): p. 1.
 5. Y. Dunham, A. S. Baron, and S. Carey, “Consequences of ‘Minimal’ Group Affiliations in Children,” *Child Development* 82 (2011): 793–811. In these experiments, the individuals in the groups were, crucially, not in competition with the other groups. The size of these effects was roughly half as big as the preference children expressed for their own gender, though the gender preference was mainly evinced by little girls favoring other girls (boys favored other boys and girls equally).
 6. Three-month-olds already prefer faces of their own race. D. Kelly et al., “Three-Month-Olds, but Not Newborns, Prefer Own-Race Faces,” *Developmental Science* 8 (2005): F31–F36. Five-month-olds prefer their native language and shun foreign accents. K. D. Kinzler, E. Dupoux, and E. S. Spelke, “The Native Language of Social Cognition,” *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 12577–12580.
 7. P. Bloom, *Just Babies: The Origins of Good and Evil* (New York: Crown, 2013).
 8. J. K. Hamlin, K. Wynn, and P. Bloom, “3-Month-Olds Show a Negativity Bias in Their Social Evaluations,” *Developmental Science* 13 (2010): 923–929.
 9. Y. J. Choi and Y. Luo, “13-Month-Olds’ Understanding of Social Interactions,” *Psychological Science* 26 (2015): 274–283.
 10. F. Warneken and M. Tomasello, “Altruistic Helping in Human Infants and Young Chimpanzees,” *Science* 311 (2006): 1301–1303.
 11. For an expansive treatment of this phenomenon, which Frank White has called “the overview effect,” see F. White, *The Overview Effect: Space Exploration and Human Evolution*, 3rd ed. (Reston, VA: American Institute of Aeronautics and Astronautics, 2014). The quotes from Aleksandrov and Williams are widely attributed online, but I could not find the original sources. Two similar quotes, with sources, include the following: “You develop an instant global consciousness, a people orientation, an intense dissatisfaction with the state of the world, a compulsion to do something about it. From out there on the moon, international politics looks so petty.” Edgar Mitchell (Apollo 14 astronaut), “Edgar Mitchell’s Strange Voyage,” *People*, April 8, 1974. “When you’re finally up at the moon looking back on Earth, all those differences and nationalistic traits are pretty well going to blend, and you’re going to get a concept that maybe this really is one world and why the hell can’t we learn to live together like decent people.” Frank Borman (Apollo 8 astronaut), “Christmas Journey,” *Newsweek*, December 23, 1968.
 12. D. Keltner and J. Haidt, “Approaching Awe, a Moral, Spiritual, and Aesthetic Emotion,” *Cognition and Emotion* 17 (2003): 297–314. Of course, we may also be awestruck by beautiful music, deep scientific theories, or even a charismatic leader, not just by nature.

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13. For instance, chimpanzees appear to have goose bumps during thunderstorms. J. Marchant, “Awesome Awe: The Emotion That Gives Us Superpowers,” *New Scientist*, July 26, 2017.
14. The right to have a name is so universal that it was even codified by the UN. See Office of the United Nations High Commissioner for Human Rights, *Convention on the Rights of the Child, Adopted and opened for signature, ratification and accession by General Assembly resolution 44/25 of 20 November 1989 entry into force 2 September 1990, in accordance with article 49*. A very few societies (e.g., the Machiguenga), do not have personal names but use other sorts of descriptors to uniquely identify people.
15. J. Fajans, *Work and Play Among the Baining of Papua New Guinea* (Chicago: University of Chicago Press, 1997).
16. The first person to use this terminology may have been Charles Darwin. In a letter to J. D. Hooker in 1857, he noted that “those who make many species are the ‘splitters,’ and those who make few are the ‘lumpers.’” C. Darwin and F. Darwin, *The Life and Letters of Charles Darwin*, vol. 2 (London: John Murray, 1887), day 153. These terms were introduced more widely in G. G. Simpson, “The Principles of Classification and a Classification of Mammals,” *Bulletin of the American Museum of Natural History* 85 (1945): 22–24.
17. D. M. Buss, “Human Nature and Culture: An Evolutionary Psychological Perspective,” *Journal of Personality* 69 (2001): 955–978.
18. C. Geertz, *The Interpretation of Cultures: Selected Essays* (New York: Basic Books, 1973), pp. 40–41.
19. S. Pinker, *The Blank Slate: The Modern Denial of Human Nature* (New York: Penguin, 2002).
20. See D. E. Brown, *Human Universals* (New York: McGraw-Hill, 1991), pp. 58–59, 66–67. Another influential midcentury essay, by Clyde Kluckhorn, also proposed the possibility of biological and psychological explanations for cultural universals in addition to the possibilities of shared social interactions and shared environmental contexts. C. C. Kluckhorn, “Universal Categories of Culture,” in A. L. Kroeber, ed., *Anthropology Today* (Chicago: University of Chicago Press, 1953), pp. 507–523.
21. G. P. Murdock, “The Common Denominator of Cultures,” in R. Linton, ed., *The Science of Man in a World of Crisis* (New York: Columbia University Press, 1945), pp. 123–142.
22. Brown, *Human Universals*, p. 50.
23. *Ibid.*, p. 47.
24. P. Turchin et al., “Quantitative Historical Analysis Uncover a Single Dimension of Complexity that Structures Global Variation in Human Social Organization,” *PNAS: Proceedings of the National Academy of Sciences* 115 (2018): E144—E151.
25. P. Ekman, “Facial Expressions,” in T. Dalgleish and M. Power, eds., *Handbook of Cognition and Emotion* (Chichester, UK: John Wiley and Sons, 1999), pp. 301–320. See also G. A. Bryant et al., “The Perception of Spontaneous and Volitional Laughter Across 21 Societies,” *Psychological Science* 29 (2018): 1515–1525. Of course, again, some links can be severed by very strong cultural overlays, as in decoupling smiles from happiness (as happens in some cultures). Human personality structures are also likely universal. See

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- R. R. McCrae and P. T. Costa Jr., "Personality Trait Structure as a Human Universal," *American Psychologist* 52 (1997): 509–516; and S. Yamagata et al., "Is the Genetic Structure of Human Personality Universal? A Cross-Cultural Twin Study from North America, Europe, and Asia," *Journal of Personality and Social Psychology* 90 (2006): 987–998.
26. C. Chen, C. Crivelli, O. G. B. Garrod, P. G. Schyns, J. M. Fernandez-Dols, and R. E. Jack, "Distinct Facial Expressions Represent Pain and Pleasure Across Cultures," *PNAS: Proceedings of the National Academy of Sciences* 115 (2018): E10013–E10021.
 27. N. Chomsky, *Syntactic Structures* (Berlin: Mouton de Gruyter, 1957); S. Pinker, *The Language Instinct: How the Mind Creates Language* (New York: Harper Perennial, 1995).
 28. P. E. Savage, S. Brown, E. Sakai, and T. E. Currie, "Statistical Universals Reveal the Structures and Functions of Human Music," *PNAS: Proceedings of the National Academy of Sciences* 112 (2015): 8987–8992.
 29. See, for example, R. Heinsohn, C. N. Zdenek, R. B. Cunningham, J. A. Endler, and N. E. Langmore, "Tool Assisted Rhythmic Drumming in Palm Cockatoos Shares Elements of Human Instrumental Music," *Science Advances* 3 (2017): e1602399.
 30. E. O. Wilson, *The Social Conquest of Earth* (New York: Liveright, 2013).
 31. These traits are supported by still others that are expressed on a more individual level, such as a need for transcendence or a sense of purpose; a capacity to make or appreciate art and music; and a desire to tell or hear stories.
 32. Other scholars are less troubled by this metaphor. See, for example, R. Plomin, *Blueprint: How DNA Makes Us Who We Are* (Cambridge, MA: MIT Press, 2018), which explores how our genes predict our psychological strengths and weaknesses. With respect to my use of the metaphor of a blueprint, it's worth noting that I take our capacity for culture (which is evolutionarily enabled) to be part of what specifies our social order. But, more particularly, the social suite, not our DNA per se, is the blueprint for a good society.
 33. Causes of possible intergroup variation include adaptation to environment, neutral drift, reproductive isolation of human populations, and founder effects. There are also broader genetic differences in populations of humans that, generally, track the continents of origin. See L. B. Jorde and S. P. Wooding, "Genetic Variation, Classification, and 'Race,'" *Nature Genetics* 36 (2004): 528–533.
 34. A. Quamrul and O. Galor, "The Out-of-Africa Hypothesis, Human Genetic Diversity, and Comparative Development," *American Economic Review* 103 (2013): 1–46.

Chapter 2: Unintentional Communities

1. *Castaway 2000*, produced by C. Kelley, BBC One, 2000. In 2016, *Eden*, a similar reality survival show, focused on a failed community in an isolated area of Scotland. See Sam Knight, "Reality TV's Wildest Disaster: 'Eden' Aspired to Remake Society Altogether. What Could Go Wrong?," *New Yorker*, September 4, 2017.
2. R. Copey, "How *Castaway* Made My Life Hell," *Guardian*, August 11, 2010.
3. J. Kibble-White, "This is What Happens to Make Reality TV," *Off The Telly*, November 2004.
4. Copey, "How *Castaway* Made My Life Hell."

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5. G. Martin, "Return to Castaway Island: The Cast of Britain's First Reality TV Programme Reunite," *Daily Mail*, July 17, 2010.
6. Copsy, "How *Castaway* Made My Life Hell."
7. R. Shattuck, *The Forbidden Experiment: The Story of the Wild Boy of Aveyron* (New York: Farrar, Straus and Giroux, 1980).
8. K. Steel, "Feral and Isolated Children from Herodotus to Akbar to Hesse: Heroes, Thinkers, and Friends of Wolves" (presentation, CUNY Brooklyn College, April 11, 2016), https://academicworks.cuny.edu/gc_pubs/216/.
9. H. Fast, "The First Men," *Magazine for Science Fiction and Fantasy*, February 1960.
10. Demarcating what is and is not "science" is difficult, and philosophers of science have begun to think about science less in terms of specific methods and more in terms of an underlying process that the sociologist Robert K. Merton has called "organized skepticism." R. K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago: University of Chicago Press, 1973).
11. Earnings were reduced by about 15 percent (among white men) for at least ten years. This loss of earnings roughly reflects the fact that while they were serving in the military for two years, they were failing to get relevant labor market experience. J. D. Angrist, "Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records," *American Economic Review* 80 (1990): 313–336. Similar natural experiments have taken advantage of people winning monetary lotteries to evaluate the link between wealth and health, trying to sort out whether wealthy people become healthy, or healthy people become wealthy (it's both). J. Gardner and A. J. Oswald, "Money and Mental Wellbeing: A Longitudinal Study of Medium-Sized Lottery Wins," *Journal of Health Economics* 26 (2007): 49–60.
12. A. Banerjee and L. Iyer, "Colonial Land Tenure, Electoral Competition, and Public Goods in India," in J. Diamond and J. A. Robinson, eds., *Natural Experiments of History* (Cambridge, MA: Belknap Press, 2010), pp. 185–220.
13. D. Acemoglu, D. Cantoni, S. Johnson, and J. A. Robinson, "From Ancien Régime to Capitalism: The Spread of the French Revolution as a Natural Experiment," in J. Diamond and J. A. Robinson, eds., *Natural Experiments of History* (Cambridge, MA: Belknap Press, 2010), pp. 221–256.
14. A. Duncan, *The Mariner's Chronicle Containing Narratives of the Most Remarkable Disasters at Sea, Such as Shipwrecks, Storms, Fires and Famines* (New Haven, CT: G. W. Gorton, 1834). See also M. Gibbs, "Maritime Archaeology and Behavior During Crisis: The Wreck of the VOC Ship *Batavia* (1629)," in R. Torrence and J. Grattan, eds., *Natural Disasters and Cultural Change* (Abingdon, UK: Routledge, 2002), pp. 66–86.
15. J. Lichfield, "Shipwrecked and Abandoned: The Story of the Slave Crusoes," *Independent*, February 4, 2007.
16. C. A. Dard, J. G. des Odonais, and P.-R. de Brisson, *Perils and Captivity: Comprising the sufferings of the Picard family after the shipwreck of the Medusa, in the year 1816; Narrative of the captivity of M. de Brisson, in the year 1785; Voyage of Madame Godin along the river of the Amazons, in the year 1770*, trans. P. Maxwell (Edinburgh: Constable; London: Thomas Hurst, 1827); P. Viaud, *The Shipwreck and Adventures of Monsieur Pierre Viaud* (London:

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- T. Davies, 1771). Cannibalism is left out of the much shorter account of Monsieur Viaud's adventures published in the anonymous compendium *Tales of Shipwreck and Peril at Sea* (London: Burns and Lambert, 1858).
17. Regarding the case of the Andes survivors, see P. P. Read, *Alive: The Story of the Andes Survivors* (New York: J. B. Lippincott, 1974).
 18. According to historian Keith Huntress, the earliest collection of shipwreck narratives was published in London in 1675, in the form of *Mr. James Janeway's Legacy to His Friends, Containing Twenty-Seven Famous Instances of God's Providence in and About Sea-Dangers and Deliverances*. K. Huntress, *Narratives of Shipwrecks and Disasters* (Ames: Iowa State University Press, 1974).
 19. M. Nash, *The Sydney Cove Shipwreck Survivors Camp*, Flinders University Maritime Archaeology Monograph Series, no. 2 (Adelaide: Flinders University Department of Archaeology, 2006).
 20. That is, while we may know about wrecks, we often do not know about how the survivors were able to rebuild a society. For example, the *Tamaris*, a French brig bound for New Caledonia, was wrecked on the Crozet Islands in 1887, leaving the thirteen-man crew stranded on the uninhabited, cold, windy, and treeless island of Île aux Cochons. Desperate for any help, the men attached a note pleading for rescue to the leg of a large seabird, a note that, astonishingly, was found seven months later in Fremantle, Western Australia, more than four thousand miles away. The men, however, were never located. "The Crozet Islands," *Adelaide Express and Telegraph*, March 21, 1889.
 21. To estimate the total number of shipwrecks that occurred between the years 1500 and 1900, I (along with my capable research assistants) made use of the data set regarding over 176,000 wrecks compiled on the website Wrecksite.com (<https://www.wrecksite.eu>) as of 2016. This site attempts to catalog all ships lost worldwide, including causes other than shipwreck (e.g., foundering, fire, naval battle, or scuttling). I filtered entries by cause of wreck, disregarding those ships that did not actually strike shore, and also eliminated all wrecks occurring outside 1500 to 1900 CE. These constraints yielded a total of over 8,100 wrecks. This includes all wrecks that hit land, including those catastrophic wrecks in which all passengers immediately perished. I was primarily concerned with shipwrecks that may have produced survival colonies on land. From the population of 8,100 wrecks, I used information in the database to select all those wrecks where a survival colony of nineteen or more people resided on land for at least sixty days, and where at least one person survived to tell the tale. I found twenty such wrecks and reviewed all first-person accounts available from these wrecks. An intriguing wreck that I did not include was the *Jamaica Sloop*, from 1711, which involved sixteen survivors who encamped for four months, as discussed in Duncan, *The Mariner's Chronicle*, pp. 242–275.

I could not find any examples from Asia. For instance, in a comprehensive sample of twenty-four cases of Japanese shipwreck survivors who drifted to the coasts of South-east Asia in the seventeenth, eighteenth, and nineteenth centuries, just three had nineteen or more people who made it to shore, and I did not include these wrecks because the subjects made rapid contact with locals and were repatriated back to Japan. S. F. Liu, "Shipwreck Salvage and Survivors' Repatriation Networks of the East

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- Asian Rim in the Qing Dynasty,” in F. Kayoko, M. Shiro, and A. Reid, eds., *Offshore Asia: Maritime Interactions in Eastern Asia Before Steamships* (Singapore: ISEAS, 2013), pp. 211–235. A search of the few naval histories of China that exist and of some searchable primary sources using the Chinese words for “shipwreck” by historian Zvi Ben-Dor Benite reveals only a handful of recorded cases, and in all cases, the sailors were rescued, often within days (Ben-Dor Benite, personal communication, July 14, 2018).
22. M. Gibbs, “The Archeology of Crisis: Shipwreck Survivor Camps in Australasia,” *Historical Archeology* 37 (2003): 128–145.
 23. F. E. Woods, *Divine Providence: The Wreck and Rescue of the Julia Ann* (Springville, UT: Cedar Fort, 2014), p. 58.
 24. *Ibid.*, p. 48.
 25. *Ibid.*, pp. 61–62.
 26. J. G. Lockhart, *Blenden Hall: The True Story of a Shipwreck, a Casting Away, and Life on a Desert Island* (New York: D. Appleton, 1930).
 27. Quoted in *ibid.*, pp. 153–154. The son was also named Alexander M. Greig.
 28. Interestingly, the HMS *Beagle* itself, on its third voyage (with Darwin no longer on board—he had been on the second voyage), stopped at the wreck site in 1842. S. Harris and H. McKenny, “Preservation Island, Furneaux Group: Two Hundred Years of Vegetation Change,” *Papers and Proceedings of the Royal Society of Tasmania* 133, no. 1 (1999): 85–101.
 29. “Supercargo William Clark’s Account,” in M. Nash, *Sydney Cove: The History and Archaeology of an Eighteenth-Century Shipwreck* (Hobart, Australia: Navarine, 2009), p. 235.
 30. *Ibid.*, p. 237. Italics added.
 31. *Ibid.*, p. 238.
 32. “Governor Hunter’s Account” (from a letter dated August 15, 1797), in *ibid.*, p. 243.
 33. Mr. Webb, “A Journal of the Proceedings of the *Doddington* East Indiaman,” in B. Plaisted, ed., *A Journal from Calcutta to England, in the Year, 1750. To Which Are Added, Directions by E. Eliot, for Passing over the Little Desert from Busserah. With a Journal of the Proceedings of the Doddington East-Indiaman*, 2nd ed. (London: T. Kinnorsly, 1758), p. 238.
 34. Tensions between crew and passengers and between men and women, as well as differential survival, have been studied in other maritime disasters. See B. S. Frey, D. A. Savage, and B. Torgler, “Interaction of Natural Survival Instincts and Internalized Social Norms Exploring the *Titanic* and *Lusitania* Disasters,” *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 4862–4865. For an examination of chivalrous norms with respect to the treatment of women and children, exploiting a sample of eighteen maritime disasters and fifteen thousand people, see M. Elinder and O. Erixson, “Gender, Social Norms, and Survival in Maritime Disasters,” *PNAS: Proceedings of the National Academy of Sciences* 109 (2012): 13220–13224. The authors observed that women had a significant survival disadvantage compared with men and that passengers had a significant disadvantage compared to captains and crew. They also concluded that the best way to describe behavior in maritime disasters was “every man for himself.”
 35. Two months into their stay, on a more careful exploration of the island, they also discovered evidence of prior castaways on Bird Island. The *Doddington* was carrying gold

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- and silver; the wreck was discovered by divers and looted two hundred years later. J. Shaw, "Clive of India's Gold Comes Up for Sale After Legal Settlement," *Independent*, August 27, 2000.
36. A prior effort to get help had not ended well. On September 3, three men set out on a risky mission to the mainland. As the small boat approached land, it was overset by surf, and one of them drowned. The two who made it ashore with the boat soon encountered hostile local people. The men were stripped of their clothes and strongly encouraged to leave. They took the hint and returned to Bird Island, barely alive.
 37. Webb, "Proceedings of the *Doddington*," p. 268.
 38. *Ibid.*, p. 269.
 39. The men had salvaged a treasure chest from the ship shortly after landfall, and on September 28, they discovered that it had been broken open and two-thirds of it had been hidden elsewhere. It was not possible to discern who had done this.
 40. G. Dalgarno, "Letter from the Captain," *Otago Witness* (Dunedin, New Zealand), October 28, 1865.
 41. Even after rescue, the officers could not be magnanimous to the seaman (Holding) whose inventive efforts on the island had actually saved them. After the rescue, Captain Dalgarno seemed pleased that, while he and Smith were entertained by the rescue ship's officers in finer accommodations, Holding was relegated to his proper station "among his fore-castle equals." J. Druett, *Island of the Lost: Shipwrecked at the Edge of the World* (Chapel Hill, NC: Algonquin Books, 2007), p. 201. Class stratification had been the doom of the *Invercauld* crew on the island. The resourceful Holding, however, died in Canada in 1933, at the age of eighty-six. An account of the *Invercauld* authored by Holding before he died was found by his great-granddaughter and published in 1997: M. F. Allen, *Wake of the Invercauld* (Auckland: Exisle Press, 1997). Captain Raynal also included a since-lost account of the *Invercauld* written by Captain Dalgarno as an appendix to his own book: F. E. Raynal, *Wrecked on a Reef, or Twenty Months Among the Auckland Isles* (London: T. Nelson and Sons, 1874).
 42. "Captain and Mate," *Otago Witness* (Dunedin, New Zealand), October 28, 1865. Lest we judge Dalgarno too harshly, in the foregoing account he noted, perhaps self-servingly, that when his boat sank, "everything in and belonging to the vessel was lost, including a medal presented to me in the year 1862 by the United States Government, for saving the lives of the crew of a water-logged vessel, and a telescope presented to me by the British Government in the same year, for saving the lives of the crew of a British vessel . . . both of which I valued most highly, as mementos of service which I had been enabled to perform to brother seamen."
 43. Some contemporary research suggests that demographic diversity may be beneficial to group performance, subject to certain provisos. See E. Smith and Y. Hou, "Redundant Heterogeneity and Group Performance," *Organization Science* 26 (2014): 37–51.
 44. Raynal's account, *Wrecked on a Reef*, was originally published in French. Musgrave's was published as T. Musgrave, *Castaway on the Auckland Isles: A Narrative of the Wreck of the 'Grafton' and the Escape of the Crew After Twenty Months Suffering* (London: Lockwood, 1866).
 45. Musgrave, *Castaway*, p. ix.
 46. Raynal, *Wrecked on a Reef*, p. 82.

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47. *Ibid.*, pp. 159–160.
48. *Ibid.*, p. 152.
49. Druett, *Island of the Lost*, pp. 163–164.
50. Musgrave, *Castaway*, p. 129. See also A. W. Eden, *Islands of Despair* (London: Andrew Melrose, 1955), p. 101.
51. W. H. Norman and T. Musgrave, *Journals of the Voyage and Proceedings of the HMCS “Victoria” in Search of Shipwrecked People at the Auckland and Other Islands* (Melbourne: F. F. Bailliere, 1866), p. 28.
52. Druett, *Island of the Lost*, p. 248.
53. *Ibid.*, p. 280.
54. S. Sheppard, “Physical Isolation and Failed Socialization on Pitcairn Island: A Warning for the Future;,” *Journal of New Zealand and Pacific Studies* 2 (2014): 21–38; D. T. Coenen, “Of Pitcairn’s Island and American Constitutional Theory,” *William and Mary Law Review* 38 (1997): 649–675.
55. Four other loyalists were also later set free by the mutineers.
56. R. B. Nicolson, *The Pitcairners* (Honolulu: University of Hawaii Press, 1997).
57. T. Lummis, *Life and Death in Eden: Pitcairn Island and the Bounty Mutineers* (Farnham, UK: Ashgate, 1997), p. 46.
58. R. W. Kirk, *Pitcairn Island, the Bounty Mutineers, and Their Descendants: A History* (Jefferson, NC: McFarland, 2008).
59. H. L. Shapiro, *The Pitcairn Islanders* (formerly “*The Heritage of the Bounty*”) (New York: Simon and Schuster, 1968), p. 54.
60. Sheppard, “Physical Isolation.”
61. *Ibid.*, p. 31.
62. Teehuteatuanoa [Jenny], “Account of the Mutineers of the Ship *Bounty*, and Their Descendants at Pitcairn’s Island,” *Sydney Gazette*, July 17, 1819.
63. Lummis, *Life and Death in Eden*, p. 63.
64. Teehuteatuanoa, “Account of the Mutineers.”
65. *Ibid.*
66. Lummis, *Life and Death in Eden*, p. 69.
67. *Pitcairn Island Encyclopedia*, s.v. “Pitcairn Islands Study Center: Folger, Mayhew,” with text taken from S. Wahlroos, *Mutiny and Romance in the South Seas: A Companion to the Bounty Adventure* (Salem, MA: Salem House, 1989). Capitalization modernized. Visiting the island community another forty-two years later, Walter Brodie, a New Zealand sailor who was temporarily stranded on Pitcairn, similarly marveled at the community’s warmth and hospitality. W. Brodie, *Pitcairn’s Island and the Islanders in 1850. Together with Extracts from His Private Journal and a Few Hints Upon California: Also, the Reports of All the Commanders of H.M. Ships That Have Touched at the Above Island Since 1800* (London: Whittaker, 1851), pp. 30–32.
68. For a summary of the trial, see “Six Found Guilty in Pitcairn Sex Offences Trial,” *Guardian*, October 25, 2004.
69. J. Diamond, *Collapse: How Societies Choose to Fail or Succeed* (New York: Penguin, 2005).
70. M. Weber, *The Vocation Lectures*, ed. D. S. Owen and T. B. Strong, trans. R. Livingstone (Indianapolis: Hackett, 2004).

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71. "Shackleton's Voyage of Endurance," *NOVA*, season 29, episode 6, first aired March 26, 2002, on PBS. The original version of the ad in the *Times* (UK) has never been located by historians, leading a growing body of researchers to think that it may have been fabricated. Some organizations even offer a monetary reward for the original ad.
72. M. T. Fisher and J. Fisher, *Shackleton* (London: Barrie, 1957); R. Huntford, *Shackleton* (New York: Carroll and Graf, 1998).
73. Fisher and Fisher, *Shackleton*, p. 340.
74. *Ibid.*, p. 345.
75. F. Hurley, *The Diaries of Frank Hurley, 1912–1941*, ed. R. Dixon and C. Lee (London: Anthem Press, 2011), p. 24.
76. Fisher and Fisher, *Shackleton*, p. 345. Italics added.
77. Geographers Jared Diamond and Barry Rolett could not go back in time and, on a vast scale, experimentally assign inhabitants to sixty-nine different Polynesian islands in order to figure out why Easter Island was deforested and others were not. But they assumed that similar people settled these islands more or less at random, and they concluded, from this natural experiment, that the deforestation was due to geographic factors (such as windborne volcanic ash and rainfall) more than to various behaviors later adopted by the settlers. J. Diamond, "Intra-Island and Inter-Island Comparisons," in J. Diamond and J. A. Robinson, eds., *Natural Experiments of History* (Cambridge, MA: Belknap Press, 2010), pp. 120–141. See also Diamond, *Collapse*.
78. P. V. Kirch, "Controlled Comparison and Polynesian Cultural Evolution," in J. Diamond and J. A. Robinson, eds., *Natural Experiments of History* (Cambridge, MA: Belknap Press, 2010), p. 35.
79. M. D. Sahlins, *Social Stratification in Polynesia* (Seattle: University of Washington Press, 1958).
80. Kirch, "Controlled Comparison," pp. 27–28.
81. Irrigation probably allowed landed elites in arid areas to monopolize both water and arable land, as well as to oppose democratic rule. See J. S. Bentzen, N. Kaarsen, and A. M. Wingender, "Irrigation and Autocracy," *Journal of the European Economic Association* 15 (2017): 1–53. See also A. Sharma, S. Varma, and D. Joshi, "Social Equity Impacts of Increased Water for Irrigation," in U. A. Amarasinghe and B. R. Sharma, eds., *Strategic Analyses of the National River Linking Project (NRLP) of India, Series 2. Proceedings of the Workshop on Analyses of Hydrological, Social and Ecological Issues of the NRLP* (Colombo, Sri Lanka: International Water Management Institute, 2008).
82. For several other factors that contribute to a society manifesting human sacrifice or cannibalism, see B. Schutt, *Cannibalism: A Perfectly Natural History* (Chapel Hill, NC: Algonquin Books, 2017).
83. Liu, "Shipwreck Salvage."

Chapter 3: Intentional Communities

1. H. D. Thoreau, *A Week on the Concord and Merrimack Rivers; Walden, or Life in the Woods; The Maine Woods; Cape Cod*, ed. R. F. Sayre (New York: Literary Classics of the United States, 1985), p. 105.
2. Thoreau, *Walden*, p. 84.

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3. Ibid., p. 99.
4. Ibid., p. 102. Thoreau was not impressed with the human capacity for cooperation either: "The only cooperation which is commonly possible is exceedingly partial and superficial; and what little true cooperation there is, is as if it were not, being a harmony inaudible to men." Ibid., p. 55.
5. Ibid., p. 128.
6. M. Meltzer, *Henry David Thoreau: A Biography* (Minneapolis: Twenty-First Century Books, 2007).
7. H. D. Thoreau, *Walden and Civil Disobedience: Complete Texts with Introduction, Historical Contexts, Critical Essays* (Boston: Houghton Mifflin, 2000).
8. F. Tönnies, *Community and Society* [originally published as *Gemeinschaft und Gesellschaft*], ed. and trans. C. P. Loomis (East Lansing: Michigan State University Press, 1957). M. Weber, *Economy and Society* [originally published as *Wirtschaft und Gesellschaft*], ed. and trans. G. Roth and C. Wittich (Berkeley: University of California Press, 1978).
9. B. Zablocki, *Alienation and Charisma: A Study of Contemporary American Communes* (New York: Free Press, 1980).
10. D. E. Pitzer, *America's Communal Utopias* (Chapel Hill: University of North Carolina Press, 1997).
11. T. More, *Utopia: Written in Latin by Sir Thomas More, Chancellor of England; Translated into English*, trans. G. Burnet (London: printed for R. Chiswell, 1684).
12. Pitzer, *America's Communal Utopias*, p. 5.
13. C. Nordhoff, *The Communistic Societies of the United States, from Personal Visit and Observation* (New York: Harper and Brothers, 1875). See also J. H. Noyes, *History of American Socialisms* (Philadelphia: J. B. Lippincott, 1870); and A. F. Tyler, *Freedom's Ferment: Phases of American Social History from the Colonial Period to the Outbreak of the Civil War* (New York: Harper and Row, 1944).
14. E. Green, "Seeking an Escape Hatch from Trump's America," *Atlantic*, January 15, 2017.
15. There were perhaps ten thousand such communities of varying size across the United States in the 1960s. By 1995, there were only five hundred groups active in North America, according to one census. Pitzer, *America's Communal Utopias*, p. 12.
16. A. de Tocqueville, *Democracy in America* [originally published as *De la démocratie en Amérique*], trans. H. Reeve (London: Saunders and Otley, 1838).
17. R. W. Emerson, cited in E. K. Spann, *Brotherly Tomorrows: Movements for a Cooperative Society in America, 1820–1920* (New York: Columbia University Press, 1989), p. 52.
18. A. R. Schultz and H. A. Pochmann, "George Ripley: Unitarian, Transcendentalist, or Infidel?," *American Literature* 14 (1942): 1–19.
19. J. Myerson, "Two Unpublished Reminiscences of Brook Farm," *New England Quarterly* 48 (1975): 253–260.
20. George Ripley, cited in Spann, *Brotherly Tomorrows*, p. 56.
21. Myerson, "Two Unpublished Reminiscences."
22. Ibid., p. 256.
23. S. F. Delano, *Brook Farm: The Dark Side of Utopia* (Cambridge, MA: Harvard University Press, 2004), pp. 60–76.

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24. R. Francis, "The Ideology of Brook Farm," *Studies in the American Renaissance* (1977): 1–48.
25. *Ibid.*, p. 11.
26. J. Haidt, *The Righteous Mind: Why Good People Are Divided by Politics and Religion* (New York: Pantheon, 2012), chap. 10.
27. Francis, "Ideology of Brook Farm," pp. 14–15.
28. A. E. Russell, *Home Life of the Brook Farm Association* (Boston: Little, Brown, 1900), p. 15.
29. Myerson, "Two Unpublished Reminiscences," p. 259.
30. C. A. Dana, cited in Francis, "Ideology of Brook Farm," p. 8.
31. Russell, *Home Life*, p. 24.
32. Myerson, "Two Unpublished Reminiscences," p. 256.
33. Fourier's ideas had to do with the laws of symmetry and seriality in the natural world and with idealized dwellings for self-sufficient communities of 1,620 people, sorted by personality type and occupation, which he called "phalanxes." Fourier had mostly progressive ideas about the equality of women and the instruction of children and about homosexuality and casual sex (which were permitted in his theory). C. Fourier, *Theory of Social Organization* (New York: C. P. Somerby, 1876). Fourier's thinking inspired perhaps thirty utopian communities in the United States.
34. Russell, *Home Life*, p. 2.
35. *Ibid.*, p. 134.
36. C. A. Russell, "The Rise and Decline of the Shakers," *New York History* 49 (1968): 29–55.
37. For a contemporaneous account of the reception of the Shakers, see V. Rathbun, *An Account of the Matter, Form, and Manner of a New and Strange Religion, Taught and Propagated by a Number of Europeans Living in a Place Called Nissequenia, in the State of New-York* (Providence, RI: Bennett Wheeler, 1781).
38. W. S. Bainbridge, "Shaker Demographics 1840–1900: An Example of the Use of U.S. Census Enumeration Schedules," *Journal for the Scientific Study of Religion* 21 (1982): 352–365.
39. *Ibid.*
40. S. J. Stein, *Shaker Experience in America* (New Haven, CT: Yale University Press, 1992).
41. M. M. Cosgel and J. E. Murray, "Productivity of a Commune: The Shakers, 1850–1880," *Journal of Economic History* 58 (1998): 494–510.
42. Stein, *Shaker Experience in America*, pp. 149–154.
43. Bainbridge, "Shaker Demographics."
44. Russell, "Rise and Decline," p. 46.
45. *Ibid.*
46. Population size was always a key consideration in survival. Just as small founding colonies of animals on an island are more susceptible to extinction, so too with small founding groups for communal living. The Amish, Hutterites, and Mormons (all religiously inspired) have endured so long in part because of their larger family size and in part because of their ongoing interactions with the outside world. They also, it bears mentioning, avoid alcohol. It may seem astonishing that alcohol can wreak such havoc on human social organization, yet, from varied sources—not only case histories of shipwrecks but also modern longitudinal research such as the eighty-year-old

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- Harvard Study of Adult Development—we have abundant evidence for this too. P. Hoehnle, “Community in Transition: Amana’s Great Change, 1931–1933,” *Annals of Iowa* 60 (2001): 1–34; R. Janzen and M. Stanton, *The Hutterites in North America* (Baltimore: Johns Hopkins University Press, 2010). Regarding alcohol, see, for example, G. E. Vaillant, *Aging Well: Surprising Guideposts to a Happier Life from the Landmark Harvard Study of Adult Development* (Boston: Little, Brown, 2003).
47. M. Palgi and S. Reinharz, eds., *One Hundred Years of Kibbutz Life: A Century of Crises and Reinvention* (New Brunswick, NJ: Transaction, 2014), p. 2.
 48. B. Beit-Hallahmi and A. I. Rabin, “The Kibbutz as a Social Experiment and as a Child-Rearing Laboratory,” *American Psychologist* 32 (1977): 533.
 49. D. Lieberman and T. Lobel, “Kinship on the Kibbutz: Co-Residence Duration Predicts Altruism, Personal Sexual Aversions and Moral Attitudes Among Communally Reared Peers,” *Evolution and Human Behavior* 33 (2012): 26–34.
 50. O. Aviezer, M. H. Van IJzendoorn, A. Sagi, and C. Schuengel, “‘Children of the Dream’ Revisited: 70 Years of Collective Early Child Care in Israeli Kibbutzim,” *Psychological Bulletin* 116 (1994): 99–116.
 51. Plato, *The Republic*, trans. B. Jowett (New York: Vintage Books, 1991), bk. 5.
 52. This idea is explored in J. Rawls, *A Theory of Justice* (Cambridge, MA: Harvard University Press, 1971). For a more recent summary of the debate, see A. L. Alstott, “Is the Family at Odds with Equality? The Legal Implications of Equality for Children,” *Southern California Law Review* 82, no. 1 (2008): 1–43.
 53. One of my former graduate students, Peter Dewan, grew up in a commune known as the Fort Hill Community or the Lyman Family, which was active beginning in the 1960s and where he was reared collectively. Dewan confirmed that lack of sexual interest in his peers, and he describes a special intimacy with a larger group of sibling surrogates: “From my perspective, as one of those children, this was a success, in that I have a large kin group, and we care for each other and even each other’s children. Unfortunately, we don’t have a word for this type of kinship. It is different than blood, in that I have always recognized a special closeness to my blood relatives, as have all of the other children of the community. However, my mother, when she had my brother eighteen years after I was born, deeply regretted the childhood years that she spent apart from me, sometimes as long as three years and thousands of miles apart. She determined that she would not do that again, and it is something that I have never considered. Interestingly, although this feeling is common among the mothers, many of the children never developed strong relationships with their fathers, and the fathers never seemed to mind that much. From this perspective, I would say that collective child rearing failed. Nobody continued it, and many regretted it.” Peter Dewan, personal communication, August 31, 2017. For more about this group, see R. L. Levey, “Friendly Fifty on Fort Hill—Better Way for People,” *Boston Globe*, December 12, 1967; and D. Johnston, “Once-Notorious ‘60s Commune Evolves into Respectability,” *Los Angeles Times*, August 4, 1985.
 54. H. Barry and L. M. Paxton, “Infancy and Early Childhood: Cross-Cultural Codes,” *Ethnology* 10 (1971): 466–508.
 55. S. Mintz, *Huck’s Raft: A History of American Childhood* (Cambridge, MA: Belknap Press, 2004).

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56. L. Tiger and J. Shepher, *Women in the Kibbutz* (New York: Harcourt Brace Jovanovich, 1975).
57. One study found that only 59 percent of kibbutz children were securely attached to their mothers, compared with 75 percent of Israeli infants in day care. This difference seems to be due to communal sleeping arrangements resulting in a lack of parental caregiving during nighttime hours, as well as limited daytime contact. A lack of attachment to a primary caregiver has many negative effects. Aviezer et al., "‘Children of the Dream’ Revisited."
58. A. Sagi, M. E. Lamb, R. Shoham, R. Dvir, and K. S. Lewkowicz, "Parent-Infant Interaction in Families on Israeli Kibbutzim," *International Journal of Behavioral Development* 8 (1985): 273–284.
59. E. Ben-Rafael, *Crisis and Transformation: The Kibbutz at Century’s End* (Albany: State University of New York Press, 1997), p. 62.
60. Aviezer et al., "‘Children of the Dream’ Revisited."
61. The aversion to sex with peers was observed as early as the 1970s and has been subject to investigation ever since. See, for example, J. Shepher, "Mate Selection Among Second Generation Kibbutz Adolescents and Adults: Incest Avoidance and Negative Imprinting," *Archives of Sexual Behavior* 1 (1971): 293–307. For a review, see E. Shor, "The Westermarck Hypothesis and the Israeli Kibbutzim: Reconciling Contrasting Evidence," *Archives of Sexual Behavior* 44 (2015): 1–12. See also Lieberman and Lobel, "Kinship on the Kibbutz," which found that duration of co-residence predicted stronger altruistic motivations toward one another and also more moralistic attitudes toward sex between third parties who were childhood peers.
62. Aviezer et al., "‘Children of the Dream’ Revisited," p. 113.
63. Palgi and Reinharz, *One Hundred Years*.
64. R. Abramitzky, "Lessons from the Kibbutz on the Equality-Incentives Trade-Off," *Journal of Economic Perspectives* 25 (2011): 185–207. Economists who studied the crises that beset kibbutzim during this period note a significant "brain drain" problem, with highly skilled and qualified residents more likely to leave and individuals with lower wages more likely to join. See also R. Abramitzky, "The Limits of Equality: Insights from the Israeli Kibbutz," *Quarterly Journal of Economics* 123 (2008): 1111–1159.
65. Tiger and Shepher, *Women in the Kibbutz*, p. 14.
66. B. J. Ruffle and R. Sosis, "Cooperation and the In-Group–Out-Group Bias: A Field Test on Israeli Kibbutz Members and City Residents," *Journal of Economic Behavior and Organization* 60 (2006): 147–163.
67. They also stated that, despite their knowledge of the relative intractability of sex roles, they were "surprised at how the major innovations in kibbutz women’s lives have failed to stimulate the expected new social patterns." Mothers sought closer connections to their offspring due to a "species-wide attraction between mothers and their young" that was biologically and not simply culturally encoded. Tiger and Shepher, *Women in the Kibbutz*, pp. 6, 272. See also L. Tiger and R. Fox, *The Imperial Animal* (New York: Transaction, 1971); and M. E. Spiro, *Gender and Culture: Kibbutz Women Revisited* (New York: Transaction, 1979).

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68. B. F. Skinner, *Walden Two* (New York: Macmillan, 1948). In 1985, Skinner published a kind of coda, recounting what happened after the novel ended, in the voice of Professor Burriss, one of the characters. B. F. Skinner, "News from Nowhere, 1984," *Behavior Analyst* 8 (1985): 5–14.
69. Skinner, *Walden Two*, p. 194. Skinner also had other ideas that did not quite pan out as intended, including using pigeons to guide missiles during World War II and marketing his famous Skinner box for the training of children other than his own (upon whom he famously experimented). B. F. Skinner, *The Shaping of a Behaviorist* (New York: Knopf, 1979).
70. Skinner, *Shaping of a Behaviorist*, p. 292.
71. D. E. Altus and E. K. Morris, "B. F. Skinner's Utopian Vision: Behind and Beyond *Walden Two*," *Behavior Analyst* 32 (2009): 319–335. When first published, *Walden Two* sold about seven hundred copies per year.
72. Skinner, *Walden Two*, p. 22.
73. J. K. Jessup, "Utopia Bulletin," *Fortune* (October 1948): 191–198, cited in Altus and Morris, "B. F. Skinner's Utopian Vision," p. 321.
74. H. Kuhlmann, *Living Walden Two* (Urbana: University of Illinois Press, 2005); E. K. Morris, N. G. Smith, and D. E. Altus, "B. F. Skinner's Contributions to Applied Behavior Analysis," *Behavior Analyst* 28 (2005): 99–131; Altus and Morris, "B. F. Skinner's Utopian Vision."
75. Kuhlmann, *Living Walden Two*, p. 92. See also T. Jones, "The Other American Dream," *Washington Post Magazine*, November 15, 1998. The compound at Twin Oaks would eventually encompass 450 acres.
76. Kuhlmann, *Living Walden Two*, p. 102.
77. *Ibid.*, p. 98.
78. I. Komar, *Living the Dream: A Documentary Study of Twin Oaks Community* (Norwood, PA: Norwood Editions, 1983), pp. 99–101.
79. Kuhlmann, *Living Walden Two*, p. 101.
80. D. Ruth, "The Evolution of Work Organization at Twin Oaks," *Communities: Journal of Cooperative Living* 35 (1975): 58–60. See also H. Kuhlmann, "The Illusion of Permanence: Work Motivation and Membership Turnover at Twin Oaks Community," in B. Goodwin, ed., *The Philosophy of Utopia: A Special Issue of Critical Review of International Social and Political Philosophy* (London: Frank Cass, 2001), pp. 157–171.
81. Regarding the impact of high turnover in social groups, see H. Shirado, F. Fu, J. H. Fowler, and N. A. Christakis, "Quality Versus Quantity of Social Ties in Experimental Cooperative Networks," *Nature Communications* 4 (2013): 2814.
82. Komar, *Living the Dream*, p. 72. See also Jones, "The Other American Dream."
83. L. Rohter, "Isolated Desert Community Lives by Skinner's Precepts," *New York Times*, November 7, 1989.
84. Comunidad Los Horcones, "News from Now-Here, 1986: A Response to 'News from Nowhere, 1984,'" *Behavior Analyst* 9 (1986): 129–132.
85. See, for example, F. S. Keller, "Goodbye Teacher..." *Journal of Applied Behavior Analysis* 1 (1968): 79–89.
86. Kuhlmann, *Living Walden Two*, p. 190.

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87. Ibid., p. 145.
88. Zablocki, *Alienation and Charisma*. There were between 800 and 1,725 communes in the chosen urban areas. These cities had a combined population of 25.6 million people, which corresponds to as many as 7 communes per 100,000 people.
89. S. Vaisey, "Structure, Culture, and Community: The Search for Belonging in 50 Urban Communes," *American Sociological Review* 72 (2007): 851–873; A. A. Aidala and B. D. Zablocki, "The Communes of the 1970s: Who Joined and Why?," *Marriage and Family Review* 17 (1991): 87–116. The average size of 13.4 is obtained by dividing the total census of 804 adults (age fifteen and older) by 60 in data from Aidala and Zablocki. Vaisey gives a lower average, of 10.4, likely because he used fifty communes and because he restricted his analysis to respondents who provided data of diverse sorts.
90. Zablocki, *Alienation and Charisma*, p. 44.
91. Ibid., p. 96.
92. Aidala and Zablocki, "The Communes of the 1970s," p. 112.
93. Ibid., p. 108.
94. D. French and E. French, *Working Communally: Patterns and Possibilities* (New York: Russell Sage Foundation, 1975), p. 89.
95. Zablocki, *Alienation and Charisma*, p. 319.
96. Ibid., p. 124. This was from one of the sixty rural communes. Regarding leadership in these communes, see also S. L. Carlton-Ford, "Ritual, Collective Effervescence, and Self-Esteem," *Sociological Quarterly* 33 (1992): 365–387; and J. L. Martin, "Is Power Sexy?," *American Journal of Sociology* 111 (2005): 408–446.
97. Zablocki, *Alienation and Charisma*, pp. 127, 153.
98. Ibid., pp. 115–118. The values for these behaviors reported in Aidala and Zablocki, "The Communes of the 1970s," are somewhat different, likely because the latter report focuses only on the urban communes. Part of the decline in some of these nonconventional behaviors no doubt had to do with the aging of the members, and with the winding down of the Vietnam War and civil rights movement, and not simply to being in the commune.
99. Vaisey, "Structure, Culture, and Community."
100. A. A. Harrison, Y. A. Clearwater, and C. P. McKay, eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991).
101. This is a diary entry of Edward Wilson, cited in D. J. Lugg, "The Adaptation of a Small Group to Life on an Isolated Antarctic Station," in O. G. Edholm and E. K. E. Gunderson, eds., *Polar Human Biology* (Chichester UK: William Heinemann, 1973), pp. 401–409.
102. A. Lansing, *Endurance: Shackleton's Incredible Voyage* (New York: McGraw-Hill, 1959), p. 51.
103. E. K. E. Gunderson, "Psychological Studies in Antarctica: A Review," in O. G. Edholm and E. K. E. Gunderson, eds., *Polar Human Biology* (Chichester UK: William Heinemann, 1973), pp. 352–361.
104. Even though the winter-over groups are new each year, the stations still have a distinctive culture, history, and set of traditions—as well as meteorological and material exigencies—that shape behavior. For example, winter-over crews think of the summer workers as "tourists," wear specially designed patches and clothing, and have

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- traditions such as the “Three Hundred Club,” in which crew members at the South Pole station sit in a 200-degree sauna and then run outside into 100-below weather wearing nothing more than their boots. S. K. Narula, “On Getting Naked in Antarctica,” *Atlantic*, January 7, 2014.
105. In fact, conflict between naval crews and scientists had a long history during the age of European exploration, including on Captain Cook’s vessels. B. Finney, “Scientists and Seamen,” in A. A. Harrison, Y. A. Clearwater, and C. P. McKay, eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991), pp. 89–101. Upon returning from such long voyages, scientists were known to congratulate one another for their “narrow escape from naval servitude,” as Harvard botanist Asa Gray wrote to his geologist friend James Dwight Dana. Cited in W. R. Stanton, *The Great United States Exploring Expedition of 1838–1842* (Berkeley: University of California Press, 1975), p. 137.
 106. One early study of groups that wintered over in 1969–1971 found that as many as 72 percent of subjects suffered some symptoms during the winter. R. E. Strange and W. J. Klein, “Emotional and Social Adjustment of Recent U.S. Winter-Over Parties in Isolated Antarctic Station,” in O. G. Edholm and E.K.E. Gunderson, eds., *Polar Human Biology* (Chichester UK: William Heinemann, 1973), pp. 410–416. But a more recent study using psychometric testing to evaluate seventy-eight men who wintered over in 1977 found no increase in depression. D. C. Oliver, “Psychological Effects of Isolation and Confinement of a Winter-Over Group at McMurdo Station, Antarctica,” in A. A. Harrison, Y. A. Clearwater, and C. P. McKay, eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991), pp. 217–227. See also L. A. Palinkas, “Going to Extremes: The Cultural Context of Stress, Illness, and Coping in Antarctica,” *Social Science and Medicine* 35 (1992): 651–664.
 107. P. E. Cornelius, “Life in Antarctica,” in A. A. Harrison, Y. A. Clearwater, and C. P. McKay, eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991), p. 10.
 108. Gunderson, “Psychological Studies in Antarctica,” p. 357.
 109. J. C. Johnson, J. S. Boster, and L. A. Palinkas, “Social Roles and the Evolution of Networks in Extreme and Isolated Environments,” *Journal of Mathematical Sociology* 27 (2003): 89–121.
 110. P. V. Marsden, “Core Discussion Networks of Americans,” *American Sociological Review* 52 (1987): 122–131; H. B. Shakya, N. A. Christakis, and J. H. Fowler, “An Exploratory Comparison of Name Generator Content: Data from Rural India,” *Social Networks* 48 (2017): 157–168.
 111. M. C. Pachucki, E. J. Ozer, A. Barrat, and D. Cattuto, “Mental Health and Social Networks in Early Adolescence: A Dynamic Study of Objectively Measured Social Interaction Behaviors,” *Social Science and Medicine* 125 (2015): 40–50; M. Salathe, M. Kazandjieva, J. W. Lee, P. Levis, M. W. Feldman, and J. H. Jones, “A High-Resolution Human Contact Network for Infectious Disease Transmission,” *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 22020–22025; J. P. Onnela, B. N. Waber, A. Pentland, S. Schnorf, and D. Lazer, “Using Sociometers to Quantify Social Interaction Patterns,” *Scientific Reports* 4 (2014): 5604.

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112. W. M. Smith, "Observations over the Lifetime of a Small Isolated Group: Structure, Danger, Boredom, and Vision," *Psychological Reports* 19 (1966): 475–514.
113. Strictly, a network is a hyperdimensional object; it's usually not two-dimensional or even three-dimensional. This description of networks as buttons and strings is taken from N. A. Christakis and J. H. Fowler, *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives* (New York: Little, Brown, 2009).
114. In a different study of winter-over crews, when they were still all-male (1967, 1968, and 1969), altercations involving "strong verbal disagreements, an exchange of threats, or the exchange of physical blows" occurred every year, often between beakers and trades. K. Natani, J. T. Shurley, and A. T. Joern, "Inter-Personal Relationships, Job Satisfaction, and Subjective Feelings of Competence: Their Influence upon Adaptation to Antarctic Isolation," in O. G. Edholm and E. K. E. Gunderson, eds., *Polar Human Biology*, (Chichester UK: William Heinemann, 1973), pp. 384–400.
115. Palinkas, "Going to Extremes."
116. One study of ninety-three people from New Zealand who had wintered over during one of five years in the late 1960s found that 40 percent spontaneously noted the importance of "singing and games." A. J. W. Taylor, "The Adaptation of New Zealand Research Personnel in the Antarctic," in O. G. Edholm and E. K. E. Gunderson, eds., *Polar Human Biology* (Chichester UK: William Heinemann, 1973), pp. 417–429.
117. M. Weber, "Science as Vocation," in *From Max Weber: Essays in Sociology*, ed. and trans. H. H. Gerth and C. Wright Mills (Oxford: Routledge, 1991), p. 155.

Chapter 4: Artificial Communities

1. T. Standage, *The Turk: The Life and Times of the Famous Eighteenth-Century Chess-Playing Machine* (London: Walker Books, 2002).
2. H. Reese and N. Heath, "Inside Amazon's Clickworker Platform," TechRepublic, 2016, <https://www.techrepublic.com/article/inside-amazons-clickworker-platform-how-half-a-million-people-are-training-ai-for-pennies-per-task/>.
3. J. Bohannon, "Psychologists Grow Increasingly Dependent on Online Research Subjects," *Science*, June 7, 2016.
4. J. J. Horton, D. G. Rand, and R. J. Zeckhauser, "The Online Laboratory: Conducting Experiments in a Real Labor Market," *Experimental Economics* 14 (2011): 399–425; E. Snowberg and L. Yariv, "Testing the Waters: Behavior Across Participant Pools" (working paper no. 24781, National Bureau of Economic Research, June 2018).
5. M. Zelditch, "Can You Really Study an Army in the Laboratory?," in A. Etzioni, ed., *Complex Organizations*, 2nd ed. (New York: Holt, Rinehart, and Winston, 1969) pp. 528–539.
6. D. Rand, S. Arbesman, and N. A. Christakis, "Dynamic Social Networks Promote Cooperation in Experiments with Humans," *PNAS: Proceedings of the National Academy of Sciences* 108 (2011): 19193–19198.
7. D. G. Rand, M. Nowak, J. H. Fowler, and N. A. Christakis, "Static Network Structure Can Stabilize Human Cooperation," *PNAS: Proceedings of the National Academy of Sciences* 111 (2014): 17093–17098.

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8. H. Shirado, F. Fu, J. H. Fowler, and N. A. Christakis, "Quality Versus Quantity of Social Ties in Experimental Cooperative Networks," *Nature Communications* 4 (2013): 2814.
9. Rand et al., "Static Network Structure."
10. A. Nishi, H. Shirado, D. G. Rand, and N. A. Christakis, "Inequality and Visibility of Wealth in Experimental Social Networks," *Nature* 526 (2015): 426–429.
11. Regarding *Second Life*, see T. Boellstorff, *Coming of Age in Second Life: An Anthropologist Explores the Virtually Human* (Princeton, NJ: Princeton University Press, 2008). Social interactions in online games are also reviewed in N. A. Christakis and J. H. Fowler, *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives* (New York: Little, Brown, 2009).
12. K. McKeand, "Blizzard Says World of Warcraft 10.1 Million Subscriber Statement Was a 'Misquote or Misunderstanding,'" *PCGamesN*, October 5, 2016.
13. N. Ducheneaut, N. Yee, E. Nickell, and R. J. Moore, "The Life and Death of Online Gaming Communities: A Look at Guilds in World of Warcraft," *Proceedings of the SIG-CHI Conference on Human Factors in Computing Systems* (New York: ACM, 2007), pp. 839–848.
14. H. Cole and M. D. Griffiths, "Social Interactions in Massively Multiplayer Online Role-Playing Games," *CyberPsychology and Behavior* 10 (2007): 575–583.
15. P. W. Eastwick and W. L. Gardner, "Is It a Game? Evidence for Social Influence in the Virtual World," *Social Influence* 1 (2008): 1–15.
16. N. Yee, J. N. Bailenson, M. Urbanek, F. Chang, and D. Merget, "The Unbearable Like-ness of Being Digital: The Persistence of Nonverbal Social Norms in Online Virtual Environments," *CyberPsychology and Behavior* 10 (2007): 115–121.
17. E. K. Yuen, J. D. Herbert, E. M. Forman, E. M. Goetter, R. Comer, and J. C. Bradley, "Treatment of Social Anxiety Disorder Using Online Virtual Environments in Second Life," *Behavior Therapy* 44 (2013): 51–61.
18. M. Szell, R. Lambiotte, and S. Thurner, "Multirelational Organization of Large-Scale Social Networks in an Online World," *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 13636–13641.
19. D. M. Raup, "Geometric Analysis of Shell Coiling: General Problems," *Journal of Paleontology* 40 (1966): 1178–1190.
20. D. M. Raup and A. Michelson, "Theoretical Morphology of the Coiled Shell," *Science* 147 (1965): 1294–1295.
21. Raup actually had a fourth parameter, which characterized the "shape" of the "generating curve," or the shape of the aperture of the shell.
22. Subsequent studies dealt with some of the limitations and oversights of Raup's model. For example, some scholars addressed the conceptual problem of shelled organisms that change their parameters over the course of their development. Other scholars noted that Raup's three parameters were not entirely independent of one another (an unintended oversight). This is concerning because it might mean that the reason parts of the Raup cube are unoccupied is that they are mathematically impossible, not biologically implausible. Nevertheless, follow-up work by ecologist Bernard Tursch developed a more complex model with ten (rather than three) parameters, and it still shows a shell morphospace that is only partially filled by known organisms.

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- B. Tursch, "Spiral Growth: The 'Museum of All Shells' Revisited," *Journal of Molluscan Studies* 63 (1997): 547–554. Tursch also argues that the final shape of a shell is largely determined by its starting conditions, which, being starting conditions, are presumably largely genetically encoded within the organism.
23. R. Dawkins, *Climbing Mount Improbable* (New York: W. W. Norton, 1996).
 24. R. D. K. Thomas and W. E. Reif, "The Skeleton Space: A Finite Set of Organic Designs," *Evolution* 47 (1993): 341–360.
 25. S. Wolfram, *A New Kind of Science* (Champaign, IL: Wolfram Media, 2002).
 26. G. L. Stebbins, "Natural Selection and the Differentiation of Angiosperm Families," *Evolution* 5 (1951): 299–324.
 27. There is a similar explanation for why constricting snakes do not coil around their prey with their backs facing the prey: it's physically impossible for their spines to bend that way, so this behavior is just not seen. D. E. Willard, "Constricting Methods of Snakes," *Copeia* 2 (1977): 379–382.
 28. The so-called Gravner-Griffeath model generates dazzling snowflake shapes while keeping the parameter for number of sides fixed at six. This model is based on seven parameters; by allowing them to vary, it defines a world of all possible snowflakes. Many of these mathematically foreseen possible shapes do, in fact, arise. But some of them (for instance, very thin, cross-like snowflakes) might be so unstable as not to last. M. Krzywinski and J. Lever, "In Silico Flurries: Computing a World of Snowflakes," *Scientific American*, December 23, 2017.
 29. Another, more complicated issue relates to what is known as the "fitness landscape." Here, the problem is not necessarily that there isn't enough genetic availability per se, but that most organisms are sitting at the top of "adaptive peaks" (even if those peaks may be suboptimal), and shifts between peaks are less common or very difficult to achieve (and happen only through genetic drift or by traversing "adaptive ridges").
 30. M. LaBarbera, "Why the Wheels Won't Go," *American Naturalist* 121 (1983): 395–408.
 31. J. Hsu, "Walking Military Robots Stumble Toward Future," *Discover*, December 31, 2015.
 32. Dawkins, *Climbing Mount Improbable*, p. 222.
 33. R. I. M. Dunbar, "Neocortex Size as a Constraint on Group Size in Primates," *Journal of Human Evolution* 22 (1992): 469–493.
 34. J. Henrich, R. Boyd, S. Bowles, C. Camerer, E. Fehr, and H. Gintis, eds., *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies* (Oxford: Oxford University Press, 2004).
 35. L. Cronk, *That Complex Whole: Culture and the Evolution of Human Behavior* (Boulder, CO: Westview Press, 1999), p. 21.
 36. J. Sawyer and R. A. Levine, "Cultural Dimensions: A Factor Analysis of the World Ethnographic Sample," *American Anthropologist* 68 (1966): 708–731. It is also worth noting that there is path specificity in cultures too, and, just as biology can lead species down specific paths and into dead ends, so can history lead a culture to a set of practices that, while theoretically changeable, are not actually mutable.
 37. D. Brown, *Human Universals* (New York: McGraw-Hill, 1991), pp. 130–141.

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38. Such radically alien social worlds are uncommon. This may have to do not so much with a failure of imagination on the part of the authors, but rather with their need to conform to constraints imposed by what readers expect from a story. This is analogous, in many ways, to the issue of what evolution *may* yield, as opposed to what it *does* yield given environmental constraints, as discussed earlier.
39. B. M. Stableford, “The Sociology of Science Fiction” (PhD diss., University of York, UK, 1978).
40. H. G. Wells, *The Time Machine* (London: William Heinemann, 1895).
41. A. Huxley, *Brave New World* (London: Chatto and Windus, 1932); R. A. Heinlein, *Orphans of the Sky* (New York: G. P. Putnam’s Sons, 1964); G. Orwell, *Nineteen Eighty-Four* (London: Secker and Warburg, 1949).
42. C. P. Gilman, *Herland* (New York: Pantheon, 1979). Whereas Gilman’s *Herland* envisions a utopia with hyper-cooperativeness as its defining trait, William Golding’s dystopian novel *Lord of the Flies* explores the opposite end of the spectrum, imagining the striking descent of self-governance into savagery. W. Golding, *Lord of the Flies* (New York: Penguin, 1954).
43. Gilman, *Herland*, p. 60. Societal roles in *Herland* are, in fact, somewhat differentiated, with women of exceptional wisdom and nobility occupying the village temples.
44. The women credit this diversity to their systems of education and child-rearing, claiming that “so much divergence without cross-fertilization” is due partly to “the careful education, which followed each slight tendency to differ, and partly to the law of mutation.” Gilman, *Herland*, p. 77. In this way, though described as a single “unit, a conscious group,” the women each still have a separate sense of self and distinctive quirks.
45. L. Lowry, *The Giver* (New York: Random House, 1993).
46. R. Kipling, R. Jarrell, and E. Bishop, eds., *The Best Short Stories of Rudyard Kipling* (Garden City, NY: Hanover House, 1961).
47. Cronk, *That Complex Whole*, p. 33.
48. J. Tooby and L. Cosmides, “The Psychological Foundation of Culture,” in J. H. Barkow, L. Cosmides, and J. Tooby, eds., *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Oxford: Oxford University Press, 1992), pp. 19–136.
49. Our species has a very high level of genetic similarity—mostly due to founder effects from small migratory groups—compared with species like chimpanzees. This likely also imposes constraints on the societal forms we make.

Chapter 5: First Comes Love

1. H. A. Junod, *Life of a South African Tribe*, vol. 1 (London: Macmillan, 1927), pp. 353–354.
2. W. R. Jankowiak, S. L. Volsche, and J. R. Garcia, “Is the Romantic-Sexual Kiss a Near Human Universal?,” *American Anthropologist* 117 (2015): 535–539. For a short, early review of this, see I. Eibl-Eibesfeldt, *Love and Hate: The Natural History of Behavior Patterns* (New York: Holt, Rinehart and Winston, 1971), p. 129. Thankfully, kissing one’s children *does* appear to be universal, so far as I can tell.

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3. E. W. Hopkins, "The Sniff-Kiss in Ancient India," *Journal of the American Oriental Society* 28 (1907): 120–134.
4. Jankowiak, Volsche, and Garcia, "Romantic-Sexual Kiss."
5. Yet kissing is extremely common in Arctic foragers. Also, societies with more complex social systems involving social stratification (e.g., industrialized societies with distinct social classes) evince romantic kissing more often than egalitarian societies (e.g., foragers). It is unclear why this is the case; it may relate to factors such as improved oral hygiene or an emphasis on formalized emotional displays in more complex societies.
6. F. B. M. de Waal, "The First Kiss: Foundations of Conflict Resolution Research in Animals," in F. Aureli and F. B. M. de Waal, eds., *Natural Conflict Resolution* (Berkeley: University of California Press, 2000), pp. 15–33; R. Wlodarski and R. I. M. Dunbar, "Examining the Possible Functions of Kissing in Romantic Relationships," *Archives of Sexual Behavior* 42 (2013): 1415–1423.
7. For instance, Bronislaw Malinowski's classic (if unfortunately titled) 1929 account *The Sexual Life of Savages in Northwestern Melanesia* describes the Trobrianders' bemused impression of kissing. B. Malinowski, *The Sexual Life of Savages in Northwestern Melanesia* (New York: Halcyon House, 1929), p. 331.
8. C. Wagley, *Welcome of Tears: The Tapirapé Indians of Central Brazil* (New York: Oxford University Press, 1977), p. 158.
9. Wagley's informants also denied the practice of cunnilingus, though they did provide accounts of fellatio (which was not uncommon) and homosexuality. Homosexual men were deemed especially good candidates to accompany hunting parties that would be absent from camp a long time, and there did not appear to be much opprobrium associated with homosexual behavior.
10. E. E. Evans-Pritchard, *Kinship and Marriage Among the Nuer* (Oxford: Clarendon Press, 1901). See also G. H. Herdt, *Same Sex, Different Cultures: Gays and Lesbians Across Cultures* (Boulder, CO: Westview Press, 1997).
11. T. A. Kohler et al., "Greater Post-Neolithic Wealth Disparities in Eurasia Than in North America and Mesoamerica," *Nature* 551 (2017): 619–622.
12. E. D. Gould, O. Moav, and A. Simhon, "The Mystery of Monogamy," *American Economic Review* 98 (2008): 333–357; J. Henrich, R. Boyd, and P. J. Richerson, "The Puzzle of Monogamous Marriage," *Philosophical Transactions of the Royal Society B* 367 (2012): 657–669.
13. S. J. Gould and E. S. Vrba, "Exaptation—a Missing Term in the Science of Form," *Paleobiology* 8 (1982): 4–15.
14. In the anthropological sense, there are at least three fundamental axes along which societies can be organized with respect to sex: patriarchy versus matriarchy (where the power and decision-making are situated); patrilocal versus matrilineal (whether people live with or near their fathers or their mothers); and patrilineal versus matrilineal (whether ancestry and property follow the paternal or maternal line).
15. J. Henrich, S. J. Heine, and A. Norezayan, "The Weirdest People in the World?," *Behavioral and Brain Sciences* 33 (2010): 61–135.

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16. D. R. White et al., "Rethinking Polygyny: Co-Wives, Codes, and Cultural Systems," *Current Anthropology* 29 (1988): 529–572.
17. UN Department of Economic and Social Affairs, *Population Facts*, December 2011, http://www.un.org/en/development/desa/population/publications/pdf/popfacts/PopFacts_2011-1.pdf.
18. 1 Kings 11:3 (New International Version).
19. G. M. Williams, *Handbook of Hindu Mythology* (Oxford: Oxford University Press, 2003), p. 188.
20. K. MacDonald, "The Establishment and Maintenance of Socially Imposed Monogamy in Western Europe," *Politics and the Life Sciences* 14 (1995): 3–23; W. Scheidel, "A Peculiar Institution? Greco-Roman Monogamy in Global Context," *History of the Family* 14 (2009): 280–291; D. Herlihy, "Biology and History: The Triumph of Monogamy," *Journal of Interdisciplinary History* 25 (1995): 571–583.
21. L. Betzig, "Roman Polygyny," *Ethology and Sociobiology* 13 (1992): 309–349.
22. Gould, Moav, and Simhon, "Mystery of Monogamy"; L. Betzig, "Medieval Monogamy," *Journal of Family History* 20 (1995): 181–216.
23. This numerical illustration is adapted from Henrich, Boyd, and Richerson, "Puzzle of Monogamous Marriage."
24. *Ibid.*
25. Having a lot of unpartnered, willing-to-be-violent young men could also be useful in ecological situations (perhaps of great resource scarcity) in which war between groups is inevitable or helpful to the group. The balance between intragroup and intergroup violence as well as the relative scarcity of resources are likely important, if complex, factors in guiding the emergence of monogamy.
26. Henrich, Boyd, and Richerson, "Puzzle of Monogamous Marriage," p. 660.
27. T. Hesketh and Z. W. Xing, "Abnormal Sex Ratios in Human Populations," *PNAS: Proceedings of the National Academy of Sciences* 103 (2006): 13271–13275; T. Hesketh, L. Lu, and Z. W. Xing, "The Consequences of Son Preference and Sex-Selective Abortion in China and Other Asian Countries," *Canadian Medical Association Journal* 183 (2011): 1374–1377; L. Jin, F. Elwert, J. Freese, and N. A. Christakis, "Preliminary Evidence Regarding the Hypothesis That the Sex Ratio at Sexual Maturity May Affect Longevity in Men," *Demography* 47 (2010): 579–586.
28. MacDonald, "Establishment and Maintenance"; Scheidel, "Peculiar Institution"; Herlihy, "Biology and History."
29. A. Korotayev and D. Bondarenko, "Polygyny and Democracy: A Cross-Cultural Comparison," *Cross-Cultural Research* 34 (2000): 190–208; R. McDermott and J. Cowden, "Polygyny and Violence Against Women," *Emory Law Journal* 64 (2015): 1767–1814.
30. Henrich, Boyd, and Richerson, "Puzzle of Monogamous Marriage." As always when talking about human behavior, it is important to avoid the assumption that every individual in a given society has the same sexual proclivities or the same desires for partners, whatever the cultural norm.
31. F. W. Marlowe, *The Hadza: Hunter-Gatherers of Tanzania* (Berkeley: University of California Press, 2010).

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32. R. Sear and F. W. Marlowe, "How Universal Are Human Mate Choices? Size Doesn't Matter When Hadza Foragers Are Choosing a Mate," *Biology Letters* 5 (2009): 606–609.
33. F. W. Marlowe, "Mate Preferences Among Hadza Hunter-Gatherers," *Human Nature* 15 (2004): 365–376.
34. C. L. Apicella, A. N. Crittenden, and V. A. Tobolsky, "Hunter-Gatherer Males Are More Risk-Seeking Than Females, Even in Late Childhood," *Evolution and Human Behavior* 38 (2017): 592–603.
35. A. Little, C. L. Apicella, and F. W. Marlowe, "Preferences for Symmetry in Human Faces in Two Cultures: Data from the UK and the Hadza, an Isolated Group of Hunter-Gatherers," *Proceedings of the Royal Society B* 274 (2007): 3113–3117; C. L. Apicella, A. C. Little, and F. W. Marlowe, "Facial Averageness and Attractiveness in an Isolated Population of Hunter-Gatherers," *Perception* 36 (2007): 1813–1820; C. L. Apicella and D. R. Feinberg, "Voice Pitch Alters Mate-Choice-Relevant Perception in Hunter-Gatherers," *Proceedings of the Royal Society B* 276 (2009): 1077–1082; F. W. Marlowe, C. L. Apicella, and D. Reed, "Men's Preferences for Women's Profile Waist-to-Hip Ratio in Two Societies," *Evolution and Human Behavior* 26 (2005): 458–468. See also D. M. Buss and M. Barnes, "Preferences in Human Mate Selection," *Journal of Personality and Social Psychology* 50 (1986): 559–570.
36. F. W. Marlowe, "Mate Preferences Among Hadza Hunter-Gatherers," p. 374.
37. C. L. Apicella, "Upper Body Strength Predicts Hunting Reputation and Reproductive Success in Hadza Hunter-Gatherers," *Evolution and Human Behavior* 35 (2014): 508–518.
38. K. Hawkes, J. O'Connell, and N. G. Blurton Jones, "Hunting and Nuclear Families: Some Lessons from the Hadza About Men's Work," *Current Anthropology* 42 (2001): 681–709.
39. F. W. Marlowe, "A Critical Period for Provisioning by Hadza Men: Implications for Pair-Bonding," *Evolution and Human Behavior* 24 (2003): 217–229.
40. *Ibid.*, pp. 224–225. Marlowe notes that among men who have stepchildren at home, their efforts are attenuated, in keeping with provisioning theory.
41. R. Dyson-Hudson, D. Meekers, and N. Dyson-Hudson, "Children of the Dancing Ground, Children of the House: Costs and Benefits of Marriage Rules (South Turkana, Kenya)," *Journal of Anthropological Research* 54 (1998): 19–47.
42. P. H. Gulliver, *A Preliminary Survey of the Turkana*, Communications from the School of African Studies, n.s., no. 26 (Cape Town: University of Cape Town, 1951), p. 199.
43. Generally speaking, dowry societies, where the bride's family makes a payment to the groom's family (i.e., the other way around compared with bride-wealth), are more likely to be monogamous, patrilineal, and endogamous (marrying within a group).
44. Gulliver, *Preliminary Survey*, p. 206.
45. From one point of view, the exchange of bride-wealth is adaptive, because, during times of drought, men cannot assemble the requisite amount, and so marriages (and, quite likely, births) are postponed to a time when the food supply might again be adequate (though it is unclear whether the Turkana themselves are aware of the possible benefits of such cyclicity).

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46. Gulliver, *Preliminary Survey*, p. 199.
47. *Ibid.*, pp. 198–199. This classic study of Turkana marriage, conducted in 1951, reported no instance in which this trait (fertility) was noted as essential in a partner. As many as 50 percent of firstborn children are conceived prior to marriage, according to Dyson-Hudson, Meekers, and Dyson-Hudson, “Children of the Dancing Ground,” p. 26.
48. *Ibid.* Among males, puberty (which is known as *abu akoun*, or “testes come”) is usually at age 17. Age at first marriage for women is 22.4 (± 5.2) and for men is 32.6 (± 7.2).
49. *Ibid.*
50. R. Dyson-Hudson and D. Meekers, “Universality of African Marriage Reconsidered: Evidence from Turkana Males,” *Ethnology* 35 (1996): 301–320. My grandfather Nicholas C. Christakis, described in the preface, told me a related story about his own childhood. He was orphaned as a teenager in about 1910 in Greece and had several older sisters. Greece had a dowry system, and the norm was that he had to earn the money to provide dowries for all his sisters before he himself could get married, which took him until age thirty-five.
51. *Ibid.*
52. According to Utah officials, as many as one thousand teenage boys were separated from their parents and thrown out of their communities by the polygamous Mormon sect FLDS (Fundamentalist Church of Jesus Christ of Latter-Day Saints). They were often left to fend for themselves. FLDS officials described them as “delinquents,” but Utah authorities claimed they were thrown out primarily to make younger girls available as plural wives for older, more powerful men in the sect. J. Borger, “The Lost Boys, Thrown Out of US Sect So That Older Men Can Marry More Wives,” *Guardian*, June 13, 2005.
53. P. W. Leslie, R. Dyson-Hudson, and P. H. Fry, “Population Replacement and Persistence,” in M. A. Little and P. W. Leslie, eds., *Turkana Herders of the Dry Savanna* (Oxford: Oxford University Press, 1999), pp. 281–301. However, tests of androgen levels in older Turkana men present a complex picture, in part because the practice of polygyny keeps testosterone relatively high into older age.
54. W. Jankowiak, M. Sudakov, and B. C. Wilreker, “Co-Wife Conflict and Cooperation,” *Ethnology* 44 (2005): 81–98.
55. B. I. Strassmann, “Polygyny as a Risk Factor for Child Mortality Among the Dogon,” *Current Anthropology* 38 (1997): 688–695.
56. Interestingly, it’s not only in polygynous households that we find nonrelatedness a risk factor for violence. Empirical investigations in monogamous societies demonstrate that lower degrees of relatedness among household members are associated with higher rates of abuse, neglect, and homicide. Living with genetically unrelated adults is the single biggest risk factor for a child to be abused or murdered. Conforming to familiar fairy-tale tropes, stepmothers are more than twice as likely as birth mothers to kill children, and children living with an unrelated parent are more than ten times as likely to die “accidentally.” M. Daly and M. Wilson, “Discriminative Parental Solicitude: A Biological Perspective,” *Journal of Marriage and Family* 42 (1980): 277–288; M. Daly and M. Wilson, *The Truth About Cinderella: A Darwinian View of Parental*

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- Love* (New Haven, CT: Yale University Press, 1999); V. A. Weekes-Shackelford and T. K. Shackelford, "Methods of Filicide: Stepparents and Genetic Parents Kill Differently," *Violence Victims* 19 (2004): 75–81; K. Gibson, "Differential Parental Investment in Families with Both Adopted and Genetic Children," *Evolution and Human Behavior* 30 (2009): 184–189.
57. D. MacDougall and J. MacDougall, *A Wife Among Wives*, documentary film (1981). Lorang continues: "But if she accepted a man chosen for her, she would be blessed by her parents and live happily with her husband. Then her father might give her more animals. They would help support her. That's the Turkana way."
58. *Ibid.*
59. D. MacDougall and J. MacDougall, *The Wedding Camels*, documentary film (1980).
60. S. Beckerman and P. Valentine, eds., *Cultures of Multiple Fathers: The Theory and Practice of Partible Paternity in Lowland South America* (Gainesville: University Press of Florida, 2002).
61. Wagley, *Welcome of Tears*, p. 134.
62. R. M. Ellsworth, D. H. Bailey, K. R. Hill, A. M. Hurtado, and R. S. Walker, "Relatedness, Co-Residence, and Shared Fatherhood Among Aché Foragers of Paraguay," *Current Anthropology* 55 (2014): 647–653.
63. K. G. Anderson, "How Well Does Paternity Confidence Match Actual Paternity?," *Current Anthropology* 47 (2006): 513–520.
64. G. J. Wyckoff, W. Want, and D. I. Wu, "Rapid Evolution of Male Reproductive Genes in the Descent of Man," *Nature* 403 (2000): 304–309. This has also led to all sorts of adaptations in humans, including the claim that the shape of the human penis reflects its role as a "semen displacement device," as assessed with experiments involving artificial penises and vaginas. G. G. Gallup et al., "The Human Penis as a Semen Displacement Device," *Evolution and Human Behavior* 24 (2003): 277–289. See also L. W. Simmons, R. C. Firman, G. Rhodes, and M. Peters, "Human Sperm Competition: Testis Size, Sperm Production, and Rates of Extrapair Copulations," *Animal Behaviour* 68 (2004): 297–302.
65. S. Beckerman and P. Valentine, "The Concept of Partible Paternity Among Native South Americans," in S. Beckerman and P. Valentine, eds., *Cultures of Multiple Fathers: The Theory and Practice of Partible Paternity in Lowland South America* (Gainesville: University Press of Florida, 2002), pp. 1–13.
66. On the other hand, the exact opposite may be the case for polygynous households, where evidence suggests that child survival might actually be reduced by the practice of having multiple wives (e.g., because of competition among the mothers for resources for their children). E. Smith-Greenaway and J. Trinitapoli, "Polygynous Contexts, Family Structure, and Infant Mortality in Sub-Saharan Africa," *Demography* 51 (2014): 341–366.
67. S. B. Hrdy, *Mother Nature: A History of Mothers, Infants, and Natural Selection* (New York: Pantheon, 1999).
68. C. Hua, *A Society Without Fathers or Husbands: The Na of China* (New York: Zone Books, 2001), p. 22. See also C. K. Shih, *Quest for Harmony: The Moso Traditions of Sexual Unions and Family Life* (Stanford, CA: Stanford University Press, 2010).

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69. Hua has to be especially careful to mention the “genitor” of the child, because to say “father” would evoke in non-Na readers a sense of roles and obligations that are simply not present among the Na. Hua notes that some women and children are able to identify the genitor. The role of genitors in the lives of their biological offspring might also be increasing. A quantitative study in 2008 of 140 respondents discovered that biological fathers did contribute time and money to their offspring (to a non-trivial degree) and that this was associated with positive childhood outcomes. S. M. Mattison, B. Scelza, and T. Blumenfeld, “Paternal Investment and the Positive Effects of Fathers Among the Matrilineal Mosuo of Southwest China,” *American Anthropologist* 116 (2014): 591–610.
70. Hua, *Society Without Fathers*, p. 226.
71. *Ibid.*, p. 119.
72. *Ibid.*, p. 127.
73. *Ibid.*, p. 205.
74. *Ibid.*, p. 232.
75. *Ibid.*, p. 187. I have lightly paraphrased the sort of conversation that Hua sketches here. If the man wants to refuse the woman’s overture, the last response might simply be, according to Hua, “I don’t want to come.”
76. *Ibid.*, p. 197.
77. *Ibid.*, p. 237. Italics added.
78. Cohabitation is uncommon. In one sample of data from 1963, only 10 percent of people were living in a cohabiting relationship. *Ibid.*, p. 273.
79. *Ibid.*, p. 408.
80. *Ibid.*, p. 249.
81. N. K. Choudhri, *The Complete Guide to Divorce Law*, 1st ed. (New York: Kensington, 2004).
82. Hua, *Society Without Fathers*, p. 446. Incidentally, Hua also concludes that the Na do not, in fact, have a family in any traditional sense of the word as used by anthropologists, and that their matrilineal households do not meet the definitions of this concept. I do wonder how men love children in these households. Do they feel the same warmth toward their sisters’ children as they would, in our society, feel toward their own?
83. V. Safronova, “Dating Experts Explain Polyamory and Open Relationships,” *New York Times*, October 26, 2016.
84. Hua, *Society Without Fathers*, p. 447.
85. This 5 percent figure comes from a survey by the International Institute for Population Sciences and the Population Council, cited in G. Harris, “Websites in India Put a Bit of Choice into Arranged Marriages,” *New York Times*, April 24, 2015. Based on a sample from the urban middle class of Mumbai, 8 percent of marriages in the parents’ generation and about 30 percent in the current generation are not arranged. See D. Mathur, “What’s Love Got to Do with It? Parental Involvement and Spouse Choice in Urban India” (paper, November 7, 2007), <http://dx.doi.org/10.2139/ssrn.1655998>.

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86. J. Marie, "What It's Really Like to Have an Arranged Marriage," *Cosmopolitan*, November 25, 2014.
87. "Seven Couples in Arranged Marriage Reveal When They 'Actually Fell in Love' with Each Other," *Times of India*, November 14, 2017.
88. R. Epstein, M. Pandit, and M. Thakar, "How Love Emerges in Arranged Marriages: Two Cross-Cultural Studies," *Journal of Comparative Family Studies* 43 (2013): 341–360.
89. For examples from some small studies of convenience samples, see J. Madathil and J. M. Benshoff, "Importance of Marital Characteristics and Marital Satisfaction: A Comparison of Asian Indians in Arranged Marriages and Americans in Marriages of Choice," *Family Journal* 16 (2008): 222–230; J. E. Myers, J. Madathil, and L. R. Tingle, "Marriage Satisfaction and Wellness in India and the United States: A Preliminary Comparison of Arranged Marriages and Marriages of Choice," *Journal of Counseling and Development* 83 (2005): 183–190; and P. Yelsma and K. Athappilly, "Marital Satisfaction and Communication Practices: Comparisons Among Indian and American Couples," *Journal of Comparative Family Studies* 19 (1988): 37–54.
90. P. C. Regan, S. Lakhanpal, and C. Anguiano, "Relationship Outcomes in Indian-American Love-Based and Arranged Marriages," *Psychological Reports* 110 (2012): 915–924.
91. Epstein, Pandit, and Thakar, "How Love Emerges." Divorce rates in arranged marriages are usually substantially lower than in marriages of choice, although, again, this outcome is hard to disentangle from the fact that arranged marriages typically take place in societies with other strong cultural disincentives, and even legal barriers, to divorce.
92. D. M. Buss et al., "International Preferences in Selecting Mates: A Study of 37 Cultures," *Journal of Cross-Cultural Psychology* 21 (1990): 5–47. Love ranked lower on the list in some countries, such as China and Nigeria. This survey also found that people everywhere place tremendous value on the partner characteristics of dependability, emotional stability, kindness, and intelligence—not too dissimilar from the ratings offered by the Turkana or the Hadza. Though culture had a discernible effect on what was considered desirable in a partner, there was much more similarity than difference worldwide. The factor with the greatest variation was chastity, which was highly valued in China, India, Indonesia, and Iran but was deemed irrelevant in Sweden, Finland, and Germany. Conversely, an "exciting personality" was a highly desirable spousal trait in France, Japan, Brazil, Spain, Ireland, and the United States but was deemed less important in China, India, and Iran.

Chapter 6: Animal Attraction

1. L. A. McGraw and L. J. Young, "The Prairie Vole: An Emerging Model Organism for Understanding the Social Brain," *Trends in Neuroscience* 33 (2010): 103–109.
2. T. Pizzuto and L. Getz, "Female Prairie Voles (*Microtus ochrogaster*) Fail to Form a New Pair After Loss of Mate," *Behavioural Processes* 43 (1998): 79–86.
3. Animals can also practice genetic or "true" monogamy—total sexual exclusivity in which all the pair's offspring are genetically related to them. Genetic monogamy is seen in some deep-sea fishes, where (given how hard it is for a male and female to find

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- each other) the much smaller male latches onto and can even become incorporated within the female's body, as a mere source of sperm. Genetic monogamy can also describe species in which "extra-pair matings" are exceptionally rare. It is important not to conflate the notion of a pair-bond with dyadic living in a species; that is, animals might form long-term mating unions and live apart from their mates. For a primate example, see M. Huck, E. Fernandez-Duque, P. Babb, and T. Schurr, "Correlates of Genetic Monogamy in Socially Monogamous Mammals: Insights from Azara's Owl Monkeys," *Proceedings of the Royal Society B* 281 (2014): 20140195.
4. We also see close pair-bonds in some same-sex animal pairs, such as in some species of penguins. B. Bagemihl, *Biological Exuberance: Animal Homosexuality and Natural Diversity* (New York: St. Martin's, 1999).
 5. B. B. Smuts, "Social Relationships and Life Histories of Primates," in M. E. Morbeck, A. Galloway, and A. Zihlman, eds., *The Evolving Female* (Princeton, NJ: Princeton University Press, 1997), pp. 60–68.
 6. B. Chapais, *Primeval Kinship: How Pair-Bonding Gave Birth to Human Society* (Cambridge, MA: Harvard University Press, 2008).
 7. In other taxa, 16 percent of carnivores (such as dogs, cats, and bears) and only 3 percent of ungulates (such as pigs, deer, and hippopotamuses) are monogamous. Surprisingly, monogamy is entirely absent among whales, one of the most social of species. D. Lukas and T. H. Clutton-Brock, "The Evolution of Social Monogamy in Mammals," *Science* 341 (2013): 526–530.
 8. The origin of mammals and the timing are still under investigation. See N. M. Foley, M. S. Springer, and E. C. Teeling, "Mammal Madness: Is the Mammal Tree of Life Not Yet Resolved?," *Philosophical Transactions of the Royal Society B* 371 (2016): 20150140.
 9. Lukas and Clutton-Brock, "Evolution of Social Monogamy."
 10. J. C. Mitani, "The Behavioral Regulation of Monogamy in Gibbons (*Hylobates muelleri*)," *Behavioral Ecology and Sociobiology* 15 (1984): 225–229.
 11. S. Shultz, C. Opie, and Q. D. Atkinson, "Stepwise Evolution of Stable Sociality in Primates," *Nature* 479 (2011): 219–222. Changes in dietary patterns among our ancestors might have resulted in larger female foraging ranges, which would have limited the ability of a male to guard more than one female. There are a number of possible causes of the initial shift from solitary to social living in primates. Living in groups would have reduced the risk of predation that followed a prior evolutionary shift from a nocturnal lifestyle to a diurnal one. Moreover, once a lineage becomes social, it remains social; there were no reversions to solitary lifestyle patterns.
 12. W. D. Lassek and S. J. C. Gaulin, "Costs and Benefits of Fat-Free Muscle Mass in Men: Relationship to Mating Success, Dietary Requirements, and Native Immunity," *Evolution and Human Behavior* 30 (2009): 322–328; A. Sell, L. S. E. Hone, and N. Pound, "The Importance of Physical Strength to Human Males," *Human Nature* 23 (2012): 30–44.
 13. J. M. Plavcan, "Sexual Dimorphism in Primate Evolution," *American Journal of Physical Anthropology* 116 (2002): 25–53; J. M. Plavcan and C. P. van Schaik, "Intrasexual Competition and Body Weight Dimorphism in Anthropoid Primates," *American Journal of Physical Anthropology* 103 (1997): 37–68.

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14. In a letter from Thomas Jefferson to John Adams, dated October 28, 1813, Jefferson also notes this: "Formerly, bodily powers gave place among the aristoi. But since the invention of gunpowder has armed the weak as well as the strong with missile death, bodily strength, like beauty, good humor, politeness and other accomplishments, has become but an auxiliary ground of distinction." *The Adams-Jefferson Letters: The Complete Correspondence Between Thomas Jefferson and Abigail and John Adams*, ed. L. J. Cappon, vol. 2 (Chapel Hill: University of North Carolina Press, 1959), pp. 387–392.
15. C. L. Apicella, "Upper Body Strength Predicts Hunting Reputation and Reproductive Success in Hadza Hunter-Gatherers," *Evolution and Human Behavior* 35 (2014): 508–518.
16. S. Gavrilets, "Human Origins and the Transition from Promiscuity to Pair-Bonding," *PNAS: Proceedings of the National Academy of Sciences* 109 (2012): 9923–9928.
17. A. Fuentes, "Patterns and Trends in Primate Pair Bonds," *International Journal of Primatology* 23 (2002): 953–978. See also C. Opie, Q. D. Atkinson, R. I. M. Dunbar, and S. Shultz, "Male Infanticide Leads to Social Monogamy in Primates," *PNAS: Proceedings of the National Academy of Sciences* 110 (2013): 13328–13332.
18. R. O. Prum, "Aesthetic Evolution by Mate Choice: Darwin's Really Dangerous Idea," *Philosophical Transactions of the Royal Society B* 367 (2012): 2253–2265.
19. Gavrilets, "Human Origins."
20. This term is used in formal writing and is often attributed to the famous evolutionary biologist John Maynard Smith (though I have been unable to find the original reference). An early use of this expression can be seen in J. Chermak, "The Games Animals Play," *New Scientist* 75 (1977): 672–674. This is also known as *kleptogyny* (theft of females).
21. Gavrilets, "Human Origins."
22. The maximum reliably recorded number of offspring a single woman has ever produced is sixty-nine (a Russian woman in the eighteenth century). M. M. Clay, *Quadruplets and Higher Multiple Births* (Auckland: MacKeith Press, 1989), p. 96. The practice of contraception or abortion would, of course, reduce fertility. Forager populations often have very long birth intervals and longer periods of breastfeeding.
23. T. Zerjal et al., "The Genetic Legacy of the Mongols," *American Journal of Human Genetics* 72 (2003): 717–721.
24. J. Henrich, R. Boyd, and P. J. Richerson, "The Puzzle of Monogamous Marriage," *Philosophical Transactions of the Royal Society B* 367 (2012): 657–669.
25. Interest in different strategies may vary with the ovulatory cycle. M. G. Haselton and S. W. Gangestad, "Conditional Expression of Women's Desires and Men's Mate Guarding Across the Ovulatory Cycle," *Hormones and Behavior* 49 (2006): 509–518. See also D. M. Buss, "Sex Differences in Human Mate Preferences: Evolutionary Hypotheses Testing in 37 Cultures," *Behavioral and Brain Sciences* 12 (1989): 1–49.
26. E. Turkheimer, "Three Laws of Behavior Genetics and What They Mean," *Current Directions in Psychological Science* 9 (2000): 160–164.
27. T. J. C. Polderman et al., "Meta-Analysis of the Heritability of Human Traits Based on Fifty Years of Twin Studies," *Nature Genetics* 47 (2015): 702–729.
28. J. Wu, H. Xiao, H. Sun, L. Zou, and L. Q. Zhu, "Role of Dopamine Receptors in ADHD: A Systematic Meta-Analysis," *Molecular Neurobiology* 45 (2012): 605–620; C. Chen, M.

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- Burton, E. Greenberger, and J. Dmitrieva, "Population Migration and the Variation of Dopamine D4 Receptor (DRD4) Allele Frequencies Around the Globe," *Evolution and Human Behavior* 20 (1999): 309–324; R. P. Ebstein et al., "Dopamine D4 Receptor (D4DR) Exon III Polymorphism Associated with the Human Personality Trait of Novelty Seeking," *Nature Genetics* 12 (1996): 78–80; J. Benjamin, L. Li, C. Patterson, B. D. Greenberg, D. L. Murphy, and D. H. Hamer, "Population and Familial Association Between the D4 Dopamine Receptor Gene and Measures of Novelty Seeking," *Nature Genetics* 12 (1996): 81–84; M. R. Munafo, B. Yalcin, S. A. Willis-Owen, and J. Flint, "Association of the Dopamine D4 Receptor (DRD4) Gene and Approach-Related Personality Traits: Meta-Analysis and New Data," *Biological Psychiatry* 63 (2008): 197–206.
29. See, for example, J. N. Rosenquist, S. F. Lehrer, A. J. O'Malley, A. M. Zaslavsky, J. W. Smoller, and N. A. Christakis, "Cohort of Birth Modifies the Association Between FTO Genotype and BMI," *PNAS: Proceedings of the National Academy of Sciences* 112 (2015): 354–359.
 30. Typically, variation between animals or species reflects changes in the receptors for the hormone or transmitter rather than changes in the level or structure of the hormone. The variation can include the strength with which the receptors bind the hormone, the number of such receptors, the ways the receptors transmit information related to such binding, or the location of the receptors at the cellular or neuroanatomical level.
 31. L. J. Young and Z. Wang, "The Neurobiology of Pair-Bonding," *Nature Neuroscience* 7 (2004): 1048–1054.
 32. E. A. Hammock and L. J. Young, "Variation in the Vasopressin V1a Receptor Promoter and Expression: Implications for Inter- and Intraspecific Variation in Social Behaviour," *European Journal of Neuroscience* 16 (2002): 399–402.
 33. M. Nagasawa et al., "Oxytocin-Gaze Positive Loop and the Coevolution of Human-Dog Bonds," *Science* 348 (2015): 333–336.
 34. P. T. Ellison and P. B. Gray, eds., *Endocrinology of Social Relationships* (Cambridge, MA: Harvard University Press, 2009); Z. R. Donaldson and L. J. Young, "Oxytocin, Vasopressin, and the Neurogenetics of Sociality," *Science* 322 (2008): 900–904.
 35. For instance, in a simplified taxonomy, there is the explorer (which is driven primarily by the dopamine system), the builder (serotonin), the director (testosterone), and the negotiator (estrogen). H. Fisher, *Why Him? Why Her?* (New York: Henry Holt, 2009).
 36. M. M. Lim et al., "Enhanced Partner Preference in a Promiscuous Species by Manipulating the Expression of a Single Gene," *Nature* 429 (2004): 754–757.
 37. The situation is actually more complicated than this. Subsequent work by another group showed that there were other, nonmonogamous vole species that also had similar vasopressin receptors. It seems that the precise sequence of the DNA controlling the receptor expression may be important. This is an ongoing area of research. See S. Fink, L. Excoffier, and G. Heckel, "Mammalian Monogamy Is Not Controlled by a Single Gene," *PNAS: Proceedings of the National Academy of Sciences* 103 (2006): 10956–10960; and McGraw and Young, "Prairie Vole."

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38. A. Bendesky et al., “The Genetic Basis of Parental Care Evolution in Monogamous Mice,” *Nature* 544 (2017): 434–439.
39. H. Walum et al., “Genetic Variation in the Vasopressin Receptor 1a Gene (*AVPR1A*) Associates with Pair-Bonding Behavior in Humans,” *PNAS: Proceedings of the National Academy of Sciences* 105 (2008): 14153–14156.
40. Z. M. Prichard, A. J. Mackinnon, A. F. Jorm, and S. Easta, “*AVPR1A* and *OXTR* Polymorphisms Are Associated with Sexual and Reproductive Behavioral Phenotypes in Humans,” *Human Mutation* 28 (2007): 1150; T. H. Wassink et al., “Examination of *AVPR1a* as an Autism Susceptibility Gene,” *Molecular Psychiatry* 9 (2004): 968–972; N. Yirmiya et al., “Association Between the Arginine Vasopressin 1a Receptor (*AVPR1a*) Gene and Autism in a Family-Based Study: Mediation by Socialization Skills,” *Molecular Psychiatry* 11 (2006): 488–494; A. Knafo et al., “Individual Differences in Allocation of Funds in the Dictator Game Associated with Length of the Arginine Vasopressin 1a Receptor *RS3* Promoter Region and Correlation Between *RS3* Length and Hippocampal mRNA,” *Genes, Brain and Behavior* 7 (2007): 266–275. Other experiments have shown that partner preference is not just regulated genetically; it is also regulated *epigenetically*. This refers to a set of biological processes that affect how genes are expressed through processes outside the genetic sequence itself—like a set of biological on/off switches. H. Wang, F. Duclot, Y. Liu, Z. Wang, and M. Kabbaj, “Histone Deacetylase Inhibitors Facilitate Partner Preference Formation in Female Prairie Voles,” *Nature Neuroscience* 16 (2013): 919–924. Many other genes coding for many other structural and physiological aspects of our bodies surely play similar roles in our mating and social behavior. G. E. Robinson, R. D. Fernald, and D. F. Clayton, “Genes and Behavior,” *Science* 322 (2008): 896–900.
41. D. Pisonnier, J. C. Thiery, C. Fabre-Nys, P. Poindron, and E. B. Keverne, “The Importance of Olfactory Bulb Noradrenalin for Maternal Recognition in Sheep,” *Physiology and Behavior* 35 (1985): 361–363.
42. A. Bartels and S. Zeki, “The Neural Correlates of Maternal and Romantic Love,” *NeuroImage* 21 (2004): 1155–1166.
43. G. B. Wislocki, “Size, Weight, and Histology of the Testes in the Gorilla,” *Journal of Mammalogy* 23 (1942): 281–287. There are several theories about penis size in humans. One is that the penis functions as a kind of display, like a lion’s mane. Another theory posits that females among our hominid ancestors might have mated with many males in sequence and that males with longer penises were able to deposit sperm in the vagina closer to its ultimate destination. Still another theory is that large penises facilitate female orgasms and that this resulted in ancestral females preferentially mating with males with bigger penises. L. J. Young and B. Alexander, *The Chemistry Between Us: Love, Sex, and the Science of Attraction* (New York: Penguin, 2012).
44. For example, one study found that neither oral sex nor masturbation gave women the same feeling of overall satisfaction with their relationship, or the feeling of being close to their partner, that vaginal sex created. S. Brody and R. M. Costa, “Satisfaction (Sexual, Life, Relationship, and Mental Health) Is Associated Directly with Penile-Vaginal Intercourse, but Inversely with Other Sexual Behavior Frequencies,”

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- Journal of Sexual Medicine* 6 (2009): 1947–1954; S. Brody, “The Relative Health Benefits of Different Sexual Activities,” *Journal of Sexual Medicine* 7 (2010): 1336–1361.
45. Experiments with prairie voles, for example, demonstrate that virgin males are generally indifferent to one another, but once they have mated, they will fight off other males who come near their mates, and this effect (of having a partner preference and of fighting off other males) could be blocked by the administration of antagonists to certain hormones (e.g., to vasopressin). J. T. Winslow, N. Hastings, C. S. Carter, C. R. Harbaugh, and T. R. Insel, “A Role for Central Vasopressin in Pair-Bonding in Monogamous Prairie Voles,” *Nature* 365 (1993): 545–548.
 46. Spouses can have an “opposites attract” dynamic too. Examples include big spenders marrying big savers (see, e.g., S. I. Rick, D. A. Small, and E. J. Finkel, “Fatal [Fiscal] Attraction: Spendthrifts and Tightwads in Marriage,” *Journal of Marketing Research* 48 [2011]: 228–237); followers marrying leaders (see, e.g., C. D. Dryer and L. M. Horowitz, “When Do Opposites Attract? Interpersonal Complementarity Versus Similarity,” *Journal of Personality and Social Psychology* 72 [1997]: 592–603); dissimilar HLA types choosing each other (see, e.g., R. Chaix, C. Chao, and P. Donnelly, “Is Mate Choice in Humans MHC-Dependent?,” *PLOS Genetics* 4 [2008]: e1000184); or even couples who are well matched for sadomasochistic sexual interests (see, e.g., B. L. Stiles and R. E. Clark, “BDSM: A Sub-cultural Analysis of Sacrifices and Delights,” *Deviant Behavior* 32 [2011]: 158–189).
 47. R. A. Fisher, “The Correlation Between Relatives on the Supposition of Mendelian Inheritance,” *Transactions of the Royal Society of Edinburgh* 52 (1918): 399–433; S. Wright, “Systems of Mating. III: Assortative Mating Based on Somatic Resemblance,” *Genetics* 6 (1920): 144–161.
 48. B. D. Neff and T. E. Pitcher, “Genetic Quality and Sexual Selection: An Integrated Framework for Good Genes and Compatible Genes,” *Molecular Ecology* 14 (2005): 19–38; H. L. Mays Jr. and G. E. Hill, “Choosing Mates: Good Genes Versus Genes That Are a Good Fit,” *Trends in Ecology and Evolution* 19 (2004): 554–559; M. Andersson and L. W. Simmons, “Sexual Selection and Mate Choice,” *Trends in Ecology and Evolution* 21 (2006): 296–302; A. G. Jones and N. L. Ratterman, “Mate Choice and Sexual Selection: What Have We Learned Since Darwin?,” *PNAS: Proceedings of the National Academy of Sciences* 106 (2009): 10001–10008.
 49. F. de Waal and S. Gavrilets, “Monogamy with a Purpose,” *PNAS: Proceedings of the National Academy of Sciences* 110 (2013): 15167–15168; Lukas and Clutton-Brock, “Evolution of Social Monogamy”; G. Stulp, A. P. Buunk, R. Kurzban, and S. Verhulst, “The Height of Choosiness: Mutual Mate Choice for Stature Results in Suboptimal Pair Formation for Both Sexes,” *Animal Behaviour* 86 (2013): 37–46; S. A. Baldauf, H. Kullmann, S. H. Schroth, T. Thunken, and T. C. Bakker, “You Can’t Always Get What You Want: Size Assortative Mating by Mutual Mate Choice as a Resolution of Sexual Conflict,” *BMC Evolutionary Biology* 9 (2009): 129.
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 51. T. Antal, H. Ohtsuki, J. Wakeley, P. D. Taylor, and M. A. Nowak, “Evolution of Cooperation by Phenotypic Similarity,” *PNAS: Proceedings of the National Academy of Sciences*

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- 106 (2009): 8597–8600; M. A. Nowak, “Five Rules for the Evolution of Cooperation,” *Science* 314 (2006): 1560–1563; F. Fu, M. A. Nowak, N. A. Christakis, and J. H. Fowler, “The Evolution of Homophily,” *Scientific Reports* 2 (2012): 845.
52. In this case, genotypic assortative mating might turn an otherwise neutral mutant genotype into a kind of “good gene.” However, finding a mate with a minor allele might be costly when the mutant allele is not common and especially when it is not initially advantageous.
53. Jones and Ratterman, “Mate Choice”; Y. Jiang, D. I. Bolnick, and M. Kirkpatrick, “Assortative Mating in Animals,” *American Naturalist* 181 (2013): E125–E138; Russell, Wells, and Rushton, “Evidence for Genetic Similarity.”
54. R. Laurent and R. Chaix, “MHC-Dependent Mate Choice in Humans: Why Genomic Patterns from the HapMap European American Dataset Support the Hypothesis,” *Bioessays* 34 (2012): 267–271. There may also be disassortativity for similarity to one’s own face. L. M. DeBruine et al., “Opposite-Sex Siblings Decrease Attraction, but Not Prosocial Attributions, to Self-Resembling Opposite-Sex Faces,” *PNAS: Proceedings of the National Academy of Sciences* 108 (2011): 11710–11714.
55. J. Havlicek and S. C. Roberts, “MHC-Correlated Mate Choice in Humans: A Review,” *Psychoneuroendocrinology* 34 (2009): 497–512. Interestingly, some of the studies of odor preference and MHC have shown that women using oral contraceptives do not evince the same effects. To the extent that contraceptive use interferes with “natural” partner choices, it is possible that this might result in a woman subsequently finding her partner less attractive later in any marriage, and hence face a higher risk of divorce. In principle, it should be possible to test this idea epidemiologically.
56. C. Wedekind, T. Seebeck, F. Bettens, and A. J. Paepke, “MHC-Dependent Mate Preferences in Humans,” *Proceedings of the Royal Society B* 260 (1995): 245–249. See also C. Wedekind and S. Furi, “Body Odour Preferences in Men and Women: Do They Aim for Specific MHC Combinations or Simply Heterozygosity?,” *Proceedings of the Royal Society B* 264 (1997): 1471–1479.
57. While it is clear that MHC genes play a role in body odor, it is still unclear how, exactly, they do so. M. Milinski, I. Croy, T. Hummel, and T. Boehm, “Major Histocompatibility Complex Peptide Ligands as Olfactory Cues in Human Body Odour Assessment,” *Proceedings of the Royal Society B* 280 (2013): 20122889.
58. Another way that HLA might affect partner choice is through face preference. Humans clearly place a lot of emphasis on the faces of prospective mates, and there is some suggestive evidence that HLA heterozygosity is associated with faces that are judged as more attractive, at least in men. But there is a further hurdle for a man to overcome to be seen as desirable by a female partner. Women rated the faces of men whose HLA genome was similar to theirs as more attractive than HLA-dissimilar men. So, ideally, a man should carry two copies of HLA genes that differ, but these copies should *resemble* the two copies of his prospective mate if she is to find him optimal. At least, that may be the case with visual cues. Note that this imperative to resemble a mate is the *opposite* of the response to olfactory cues. The possibly opposing forces at play with respect to olfaction and vision may indicate that natural selection equipped us with the capacity to choose mates with an *optimal* level of dissimilarity in

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- HLA, rather than a maximal level. S. C. Roberts et al., "MHC-Assortative Facial Preferences in Humans," *Biology Letters* 1 (2005): 400–403.
59. To my knowledge, no one has studied HLA dissimilarity in homosexual couples. If results similar to heterosexual unions were found, it might mean that HLA preferences are generic and not tightly coupled to reproduction per se. But if these results were not found, it might mean that these phenomena are still linked to the biology of reproduction. Either result would be interesting.
60. C. Ober, L. R. Weitkamp, N. Cox, H. Dytch, D. Kostyu, and S. Elias, "HLA and Mate Choice in Humans," *American Journal of Human Genetics* 61 (1997): 497–504; P. W. Hedrick and F. L. Black, "HLA and Mate Selection: No Evidence in South Amerindians," *American Journal of Human Genetics* 61 (1997): 505–511.
61. T. Bereczkei, P. Gyuris, and G. E. Weiseld, "Sexual Imprinting in Human Mate Choice," *Proceedings of the Royal Society B* 271 (2004): 1129–1134.
62. T. J. C. Polderman et al., "Meta-Analysis of the Heritability of Human Traits Based on Fifty Years of Twin Studies," *Nature Genetics* 47 (2015): 702–709.
63. R. S. Herz and M. Inzlicht, "Sex Differences in Response to Physical and Social Factors Involved in Human Mate Selection: The Importance of Smell for Women," *Evolution and Human Behavior* 23 (2002): 359–364.
64. R. McDermott, D. Tingley, and P. K. Hatemi, "Assortative Mating on Ideology Could Operate Through Olfactory Cues," *American Journal of Political Science* 58 (2014): 997–1005.
65. A. Nishi, J. H. Fowler, and N. A. Christakis, "Assortative Mating at Loci Under Recent Natural Selection in Humans" (unpublished manuscript, 2012). Several small-scale studies have explored the extent to which humans preferentially mate with people they resemble genetically and what this might mean for evolution. See R. Sebro, T. J. Hoffman, C. Lange, J. J. Rogus, and N. J. Risch, "Testing for Non-Random Mating: Evidence for Ancestry-Related Assortative Mating in the Framingham Heart Study," *Genetic Epidemiology* 34 (2010): 674–679; and R. Laurent, B. Toupance, and R. Chaix, "Non-Random Mate Choice in Humans: Insights from a Genome Scan," *Molecular Ecology* 21 (2012): 587–596.
66. In our analysis, we did not find substantial evidence for disassortative mating in the HLA regions. Nishi, Fowler, and Christakis, "Assortative Mating." This was in keeping with some prior studies. See, for example, Chaix, Chao, and Donnelly, "Mate Choice"; and A. Derti, C. Cenik, P. Kraft, and F. P. Roth, "Absence of Evidence for MHC-Dependent Mate Selection Within HapMap Populations," *PLOS Genetics* 6 (2010): e1000925.
67. The former relates to the disadvantages of inbreeding. The latter relates to the fact that sets of genes in our genome often are coadapted and work together; reproducing with people who are *too* dissimilar from us may, therefore, break down the synergistic way such genes interact, again resulting in fewer surviving offspring. A. Helgason, S. Palsson, D. F. Gudbjartsson, T. Kristjansson, and K. Stefansson, "An Association Between the Kinship and Fertility of Human Couples," *Science* 319 (2008): 813–816.
68. K. R. Hill et al., "Co-Residence Patterns in Hunter-Gatherer Societies Show Unique Human Social Structure," *Science* 331 (2011): 1286–1289; C. L. Apicella, F. W. Marlowe,

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- J. H. Fowler, and N. A. Christakis, "Social Networks and Cooperation in Hunter-Gatherers," *Nature* 481 (2012): 497–501; M. Sikora et al., "Ancient Genomes Show Social and Reproductive Behavior of Early Upper Paleolithic Foragers," *Science* 358 (2017): 659–662.
69. M. Dyble et al., "Sex Equality Can Explain the Unique Structure of Hunter-Gatherer Bands," *Science* 348 (2015): 796–798.
70. Chapais, *Primeval Kinship*, p. 179.
71. As we saw, pair-bonding also directed male energy away from competition for mates and toward competition to be a better provider. And since pair-bonding made it possible to recognize male kin, it may have dramatically expanded the efficiency of mechanisms individuals used to favor their kin, thus also facilitating the emergence of within-group coalitions and alliances. See Gavrilets, "Human Origins"; Chapais, *Primeval Kinship*; M. Mesterton-Gibbons, S. Gavrilets, J. Gravner, and E. Akçay, "Models of Coalition or Alliance Formation," *Journal of Theoretical Biology* 274 (2011): 187–204. Once family groups and sharing were established, this set the stage for a new type of cultural selection to operate, and for the further emergence of cooperation with non-kin. P. Richerson et al., "Cultural Group Selection Plays an Essential Role in Explaining Human Cooperation: A Sketch of the Evidence," *Behavioral and Brain Sciences* 39 (2014): e30.

Chapter 7: Animal Friends

1. J. van Lawick–Goodall, *In the Shadow of Man* (Boston: Houghton Mifflin, 1971), p. 268.
2. The way we reach out to other animals says a lot about our own capacity to befriend one another, in my view. The abuse of animals also reflects vile parts of our individual or collective nature. For instance, people who abuse animals are very likely to abuse people. See, for example, R. Lockwood and G. R. Hodge, "The Tangled Web of Animal Abuse: The Links Between Cruelty to Animals and Human Violence," in R. Lockwood and F. Ascione, eds., *Cruelty to Animals and Interpersonal Violence* (West Lafayette, IN: Purdue University Press, 1998), pp. 77–82.
3. J. O'Neill, *Prodigal Genius: The Life of Nikola Tesla* (New York: Cosimo, 2006), p. 312.
4. M. Seifer, *Wizard: The Life and Times of Nikola Tesla; Biography of a Genius* (Secaucus, NJ: Birch Lane Press, 1996), p. 414.
5. O'Neill, *Prodigal Genius*, p. 316.
6. C. M. Parkes, B. Benjamin, and R. G. Fitzgerald, "Broken Heart: A Statistical Study of Increased Mortality Among Widowers," *British Medical Journal* 1, no. 5646 (1969): 740–743; F. Elwert and N. A. Christakis, "The Effect of Widowhood on Mortality by the Causes of Death of Both Spouses," *American Journal of Public Health* 98 (2008): 2092–2098; F. Elwert and N. A. Christakis, "Widowhood and Race," *American Sociological Review* 71 (2006): 16–41. There is some suggestion in Tesla's accounts that he felt a *romantic* attachment to some of his pigeons.
7. "Pet Industry Market Size and Ownership Statistics," American Pet Products Association, http://www.americanpetproducts.org/press_industrytrends.asp.
8. K. Allen, J. Blascovich, and W. B. Mendes, "Cardiovascular Reactivity and the Presence of Pets, Friends, and Spouses: The Truth About Cats and Dogs," *Psychosomatic Medicine* 64 (2002): 727–739.

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9. K. V. A. Johnson and R. I. M. Dunbar, "Pain Tolerance Predicts Human Social Network Size," *Scientific Reports* 6 (2016): 25267. Notably, opioid receptors play a role in both pain relief and social bonding.
10. T. N. Davis et al., "Animal Assisted Interventions for Children with Autism Spectrum Disorder: A Systematic Review," *Education and Training in Autism and Developmental Disabilities* 50 (2015): 316–329; R. A. Johnson et al., "Effects of Therapeutic Horseback Riding on Post-Traumatic Stress Disorder in Military Veterans," *Military Medical Research* 5 (2018): 3.
11. C. Siebert, "What Does a Parrot Know About PTSD?," *New York Times Magazine*, January 28, 2016.
12. E. W. Budge, trans., *The History of Alexander the Great, Being the Syriac Version of the Pseudo-Callisthenes*, vol. 1 (Cambridge, UK: University Press, 1889), pp. 17–18.
13. J. H. Crider, "Fala, Never in the Doghouse," *New York Times*, October 15, 1944. Roosevelt defended Fala, saying, "These Republican leaders have not been content with attacks on me, or my wife, or on my sons. No, not content with that, they now include my little dog, Fala. Well, of course, I don't resent attacks, and my family doesn't resent attacks, but Fala does resent them." For a recording and transcript of Roosevelt's speech, see "Campaign Dinner Address of Franklin Delano Roosevelt (the Fala Speech)" (Washington, DC, September 23, 1944), Wyzant, <http://www.wyzant.com/resources/lessons/history/hpol/fdr/fala>.
14. "Geese Fly with Man Who Reared Them," BBC News, December 29, 2011, <http://www.bbc.com/news/av/science-environment-16301233/geese-fly-with-man-who-reared-them>. Bill Lishman was the first person to do something similar. B. Lishman, *C'mon Geese* (Cooper-Lishman Productions, 1989), video recording.
15. J. van Lawick–Goodall, *My Friends the Wild Chimpanzees* (Washington, DC: National Geographic Society, 1967), p. 18.
16. When Goodall relayed this account of primate behavior to Louis Leakey, he replied with the famous statement "We must now redefine man, redefine tool, or accept chimpanzees as humans."
17. Jane Goodall, interview by Bill Moyers, *Bill Moyers Journal*, PBS, November 27, 2009, <http://www.pbs.org/moyers/journal/11272009/transcript3.html>.
18. Van Lawick–Goodall, *In the Shadow of Man*, p. 76.
19. Goodall, *My Friends*, p. 191.
20. J. Goodall, "Fifi Fights Back," *National Geographic*, April 2003.
21. J. Goodall, *Through a Window: My Thirty Years with the Chimpanzees of Gombe* (Boston: Houghton Mifflin, 1990).
22. Still, as intimately as Goodall came to know the chimpanzees, there were limits. As she explained in an interview in 2014, "It took over a year before I gained the trust of the chimpanzees, but I never was part of their community." J. Shorthouse and A. Gaffney, "Jane Goodall: 80 and Touring Australia," *ABC Sunshine Coast* (Australia), June 4, 2014, <http://www.abc.net.au/local/photos/2014/06/03/4017793.htm>. Two other young ethnologists, Dian Fossey and Biruté Galdikas, who studied gorillas and orangutans, respectively, followed a similar approach, entering primate communities on their terms. Fossey described the way in which her respect for the norms of hierarchy and

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- submission within gorilla communities put the gorillas at ease. See S. Montgomery, *Walking with the Great Apes* (Boston: Houghton Mifflin, 1991), and D. Fossey, *Gorillas in the Mist* (Boston: Houghton Mifflin, 1983).
23. H. Whitehead, *Analyzing Animal Societies* (Chicago: University of Chicago Press, 2009); K. Faust and J. Skvoretz, "Comparing Networks Across Space, Time, and Species," *Sociological Methodology* 32 (2002): 267–299.
 24. R. M. Seyfarth and D. L. Cheney, "The Evolutionary Origins of Friendship," *Annual Review of Psychology* 63 (2012): 153–177; M. Krützen et al., "Contrasting Relatedness Patterns in Bottlenose Dolphins (*Tursiops* sp.) with Different Alliance Strategies," *Proceedings of the Royal Society B* 270 (2003): 497–502; J. C. Mitani, "Cooperation and Competition in Chimpanzees: Current Understanding and Future Challenges," *Evolutionary Anthropology* 18 (2009): 215–227.
 25. Mitani, "Cooperation and Competition"; J. B. Silk et al., "Strong and Consistent Social Bonds Enhance the Longevity of Female Baboons," *Current Biology* 20 (2010): 1359–1361.
 26. R. C. Connor, "Dolphin Social Intelligence: Complex Alliance Relationships in Bottlenose Dolphins and a Consideration of Selective Environments for Extreme Brain Size Evolution in Mammals," *Philosophical Transactions of the Royal Society B* 362 (2007): 587–602.
 27. See, for example, J. E. Tanner, F. G. P. Patterson, G. Francine, and R. W. Byrne, "The Development of Spontaneous Gestures in Zoo-Living Gorillas and Sign-Taught Gorillas: From Action and Location to Object Representation," *Journal of Developmental Processes* 1 (2006): 69–102; J. D. Bonvillian and F. G. P. Patterson, "Early Sign-Language Acquisition: Comparisons Between Children and Gorillas," in S. T. Parker, R. W. Mitchell, and H. L. Miles, eds., *The Mentalities of Gorillas and Orangutans* (New York: Cambridge University Press, 1999), pp. 240–264; and H. S. Terrace, *Nim: A Chimpanzee Who Learned Sign Language* (New York: Columbia University Press, 1987).
 28. C. Kasper and B. Voelkl, "A Social Network Analysis of Primate Groups," *Primates* 50 (2009): 343–356.
 29. J. C. Mitani, "Male Chimpanzees Form Enduring and Equitable Social Bonds," *Animal Behaviour* 77 (2009): 633–640.
 30. Similar findings have been observed in other communities of chimpanzees. I. C. Gilby and R. W. Wrangham, "Association Patterns Among Wild Chimpanzees (*Pan troglodytes schweinfurthii*) Reflect Sex Differences in Cooperation," *Behavioral Ecology and Sociobiology* 62 (2008): 1831–1842.
 31. J. Lehmann and C. Boesch, "Sociality of the Dispersing Sex: The Nature of Social Bonds in West African Female Chimpanzees, *Pan troglodytes*," *Animal Behaviour* 77 (2009): 377–387.
 32. A. R. Parish, "Female Relationships in Bonobos (*Pan paniscus*)," *Human Nature* 7 (1996): 61–96; D. L. Cheney, "The Acquisition of Rank and the Development of Reciprocal Alliances Among Free-Ranging Baboons," *Behavioral Ecology and Sociobiology* 2 (1977): 303–318. Once again, genetic relatedness is the best predictor of a tie, as measured by proximity and grooming behaviors. Interestingly, baboons appear to have a sort of

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- hereditary social rank into which they are born (similar to human caste systems), and female social ties are more likely between individuals of the same age and rank.
33. Kasper and Voelkl, "Social Network Analysis of Primate Groups."
 34. J. C. Flack, M. Girvan, F. B. M. de Waal, and D. C. Krakauer, "Policing Stabilizes Construction of Social Niches in Primates," *Nature* 439 (2006): 426–429.
 35. Something similar happens among wolves. The death of an alpha male causes chaos in the wolf pack and leads younger male wolves to start breeding, increasing the overall number of wolves too. R. B. Wielgus and K. A. Peebles, "Effects of Wolf Mortality on Livestock Depredations," *PLOS ONE* 9 (2014): e113505.
 36. Since leaders are much less numerous than others in a group, if an epidemic begins with a random person in the group, it will more often start in, and therefore be confined to, the periphery of the population. Of course, if it happens to begin in a leader, this is worse. But this occurs less often.
 37. J. Poole, *Coming of Age with Elephants* (New York: Hyperion, 1996), p. 275.
 38. C. J. Moss, H. Croze, and P. C. Lee, *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal* (Chicago: University of Chicago Press, 2011).
 39. S. de Silva, A. D. G. Ranjeewa, and D. Weerakoon, "Demography of Asian Elephants (*Elephas maximus*) at Uda Walawe National Park, Sri Lanka Based on Identified Individuals," *Biological Conservation* 144 (2011): 1742–1752.
 40. Poole, *Coming of Age*, pp. 147–148.
 41. *Ibid.*, p. 162.
 42. *Ibid.*
 43. For some examples, see M. Scully, *Dominion: The Power of Man, the Suffering of Animals, and the Call to Mercy* (New York: St. Martin's, 2002), p. 206. Something similar, involving cross-species helping behavior, may occur with humpback whales that interfere with orca predation of seals, even rescuing seals by lifting them out of the water. See E. Kelsey, "The Power of Compassion: Why Humpback Whales Rescue Seals and Why Volunteering for Beach Cleanups Improves Your Health," *Hakai* (August 17, 2017).
 44. F. Bibi, B. Kraatz, N. Craig, M. Beech, M. Schuster, and A. Hill, "Early Evidence for Complex Social Structure in Proboscidea from a Late Miocene Trackway Site in the United Arab Emirates," *Biology Letters* 8 (2012): 670–673.
 45. P. Pecnerova et al., "Genome-Based Sexing Provides Clues About Behavior and Social Structure in the Woolly Mammoth," *Current Biology* 27 (2017): 3505–3510. A total of 69 percent of the ninety-eight mammoth specimens was male.
 46. Most members of elephant core groups share the same mitochondrial DNA haplotype (meaning that they have a common ancestor in the line of females that preceded them), and ordinarily only about 1 percent of the elephants in a core group join the group as outsiders. E. A. Archie, C. J. Moss, and S. C. Alberts, "The Ties That Bind: Genetic Relatedness Predicts the Fission and Fusion of Social Groups in Wild African Elephants," *Proceedings of the Royal Society B* 273 (2006): 513–522. This applies to the relatively unperturbed population of Amboseli. Of course, males breed with females from many core groups, and the resulting gene flow substantially reduces the genetic differentiation among core groups overall.

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47. Poole, *Coming of Age*, pp. 274–275.
48. Archie, Moss, and Alberts, “Ties That Bind”; G. Wittemyer et al., “Where Sociality and Relatedness Diverge: The Genetic Basis for Hierarchical Social Organization in African Elephants,” *Proceedings of the Royal Society B* 276 (2009): 3513–3521.
49. K. R. Hill et al., “Co-Residence Patterns in Hunter-Gatherer Societies Show Unique Human Social Structure,” *Science* 331 (2011): 1286–1289. See also C. L. Apicella, F. W. Marlowe, J. H. Fowler, and N. A. Christakis, “Social Networks and Cooperation in Hunter-Gatherers,” *Nature* 481 (2012): 497–501.
50. P. Fernando and R. Lande, “Molecular Genetic and Behavioral Analysis of Social Organization in the Asian Elephant (*Elephas maximus*),” *Behavioral Ecology and Sociobiology* 48 (2000): 84–91; Archie, Moss, and Alberts, “Ties That Bind”; Wittemyer et al., “Where Sociality and Relatedness Diverge.”
51. Wittemyer et al., “Where Sociality and Relatedness Diverge.” An apparently similar situation of elephants forming core groups with unrelated individuals has been observed in another high-predation environment in Tanzania. K. Gobush, B. Kerr, and S. Wasser, “Genetic Relatedness and Disrupted Social Structure in a Poached Population of African Elephants,” *Molecular Ecology* 18 (2009): 722–734. To be clear, non-kin friendships may exist in elephants (as in other animals), because simply assembling with others provides benefits, such as predator vigilance (especially against lions, who attack newborn elephants) and resource defense. These advantages of social structure are enough to create and maintain it, and evolution can select for it independent of any further benefits that arise from helping one’s genetic relatives.
52. C. J. Moss and J. H. Poole, “Relationships and Social Structure of African Elephants,” in R. A. Hinde, ed., *Primate Social Relationships: An Integrated Approach* (Oxford: Blackwell, 1983), pp. 315–325. See also C. Moss, *Elephant Memories: Thirteen Years in the Life of an Elephant Family* (New York: William Morrow, 1988).
53. Archie, Moss, and Alberts, “Ties That Bind.”
54. S. de Silva and G. Wittemyer, “A Comparison of Social Organization in Asian Elephants and African Savannah Elephants,” *International Journal of Primatology* 33 (2012): 1125–1141; G. Wittemyer, I. Douglas-Hamilton, and W. M. Getz, “The Socioecology of Elephants: Analysis of the Processes Creating Multi-Tiered Social Structures,” *Animal Behaviour* 69 (2005): 1357–1371. There are also two higher levels, the subpopulation and population levels.
55. Wittemyer, Douglas-Hamilton, and Getz, “Socioecology of Elephants.”
56. *Ibid.*
57. De Silva and Wittemyer, “Comparison of Social Organization.” Asian elephants occupy habitats with consistent rainfall, whereas African elephants have to move around more and potentially compete with one another more in order to forage. They also face different predation risks. Elephants in Sri Lanka have no predators (other than humans), whereas African elephant calves are sometimes taken by lions. Gregariousness in African elephants may serve as a defense against predators in three regards: first, animals foraging in open environments may seek one another’s company as a form of cover; second, clustering together may dilute the risk faced by

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- individuals; and third, animals in groups may cooperate in active defense or monitoring of predation risks. Indeed, large-scale phylogenetic analyses show that herbivores in general (not just elephants) that live in more open environments tend to be more social. T. Caro, C. Graham, C. Stoner, and J. Vargas, "Adaptive Significance of Anti-Predator Behaviour in Artiodactyls," *Animal Behaviour* 67 (2004): 205–228.
58. L. Weilgart, H. Whitehead, and K. Payne, "A Colossal Convergence," *American Scientist* 84 (1996): 278–287.
59. L. J. N. Brent, D. W. Franks, E. A. Foster, K. C. Balcomb, M. A. Cant, and D. P. Croft, "Ecological Knowledge, Leadership, and the Evolution of Menopause in Killer Whales," *Current Biology* 25 (2015): 746–750.
60. D. Lusseau, "The Emergent Properties of a Dolphin Social Network," *Proceedings of the Royal Society B* 270 (2003): S186–S188. The transitivity was likely somewhat artificially inflated here for technical reasons having to do with the fact that the mapping of the networks originated in the bipartite graph of 1,292 groups of individual dolphins seen together.
61. D. Lusseau and M. E. J. Newman, "Identifying the Role That Animals Play in Their Social Networks," *Proceedings of the Royal Society B* 271 (2004): S477–S481.
62. J. Wiszniewski, D. Lusseau, and L. M. Moller, "Female Bisexual Kinship Ties Maintain Social Cohesion in a Dolphin Network," *Animal Behaviour* 80 (2010): 895–904.
63. Lusseau, "Emergent Properties." These dolphins appear *not* to manifest degree assortativity.
64. R. Williams and D. Lusseau, "A Killer Whale Social Network Is Vulnerable to Targeted Removals," *Biology Letters* 2 (2006): 497–500; E. A. Foster et al., "Social Network Correlates of Food Availability in an Endangered Population of Killer Whales, *Orcinus orca*," *Animal Behaviour* 83 (2012): 731–736; O. A. Filatova et al., "The Function of Multi-Pod Aggregations of Fish-Eating Killer Whales (*Orcinus orca*) in Kamchatka, Far East Russia," *Journal of Ethology* 27 (2009): 333–341.
65. For an example of a paper taking a dim view of the possibility of primate friendships, see S. P. Henzi and L. Barrett, "Coexistence in Female-Bonded Primate Groups," *Advances in the Study of Behavior* 37 (2007): 43–81.
66. Attributed to David Premack in Seyfarth and Cheney, "Evolutionary Origins."
67. *Ibid.*
68. Scully, *Dominion*, p. 194.
69. W. C. McGrew and L. Baehren, "'Parting Is Such Sweet Sorrow,' but Only for Humans?," *Human Ethology Bulletin* 31 (2016): 5–14.
70. S. R. de Kort and N. J. Emory, "Corvid Caching: The Role of Cognition," in T. Zentall and E. A. Wasserman, eds., *The Oxford Handbook of Comparative Cognition* (Oxford: Oxford University Press, 2012), pp. 390–408; L. P. Acredolo, "Coordinating Perspectives on Infant Spatial Orientation," in R. Cohen, ed., *The Development of Spatial Cognition* (Hillsdale, NJ: Lawrence Erlbaum, 1985), pp. 115–140; P. Bloom, *Just Babies: The Origins of Good and Evil* (New York: Broadway Books, 2013).
71. S. Perry, C. Barrett, and J. Manson, "White-Faced Capuchin Monkeys Show Triadic Awareness in Their Choice of Allies," *Animal Behaviour* 67 (2004): 165–170. For more examples, see R. W. Wrangham, "Social Relationships in Comparative Perspective,"

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- in R. A. Hinde, ed., *Primate Social Relationships: An Integrated Approach* (Oxford: Blackwell, 1983), pp. 325–334.
72. Seyfarth and Cheney, “Evolutionary Origins,” p. 168.
 73. J. B. Silk, “Using the ‘F’-Word in Primatology,” *Behaviour* 139 (2002): 421–446.
 74. A. S. Griffin and S. A. West, “Kin Discrimination and the Benefit of Helping in Cooperatively Breeding Vertebrates,” *Science* 302 (2003): 634–636.
 75. P. G. Hepper, ed., *Kin Recognition* (Cambridge: Cambridge University Press, 1991).
 76. W. D. Hamilton, “The Genetical Evolution of Social Behaviour, Pt. 1,” *Journal of Theoretical Biology* 7 (1964): 1–16.
 77. To be clear, just because kinship facilitates the emergence of altruism and cooperation does not mean that it is always required for those nice behaviors to appear.
 78. Hamilton, “Genetical Evolution, Pt. 1,” p. 16.
 79. S. A. Frank, “Natural Selection. VII: History and Interpretation of Kin Selection Theory,” *Journal of Evolutionary Biology* 26 (2013): 1151–1184; S. A. West, I. Pen, and A. S. Griffin, “Cooperation and Competition Between Relatives,” *Science* 296 (2002): 72–75.
 80. K. Belson, “Elders Offer Help at Japan’s Crippled Reactor,” *New York Times*, June 27, 2011. This idea can be accommodated in Hamilton’s equation by adding terms for the reproductive value, v_r , for the recipient (v_r) and the giver (v_g), as in $rBv_r - Cv_g > 0$. What this accomplishes is to modify the relative benefits and costs that accrue according to the reproductive value of who is giving and who is receiving.
 81. C. J. Barnard and P. Aldhous, “Kinship, Kin Discrimination, and Mate Choice,” in P. G. Hepper, ed., *Kin Recognition* (Cambridge: Cambridge University Press, 1991), pp. 125–147.
 82. W. G. Holmes and P. W. Sherman, “Kin Recognition in Animals,” *American Scientist* 71 (1983): 46–55.
 83. F. W. Peek, E. Franks, D. Case, “Recognition of Nest, Eggs, Nest Site, and Young in Female Red-Winged Blackbirds,” *Wilson Bulletin* 84 (1972): 243–249.
 84. T. Aubin, P. Jouventin, and C. Hildebrand, “Penguins Use the Two-Voice System to Recognize Each Other,” *Proceedings of the Royal Society B* 267 (2000): 1081–1087.
 85. J. Mehler, J. Bertoncini, and M. Barriere, “Infant Recognition of Mother’s Voice,” *Perception* 7 (1978): 491–497. Even fetuses can recognize their mothers’ voices. B. S. Kisilevsky et al., “Effects of Experience on Fetal Voice Recognition,” *Psychological Science* 14 (2003): 220–224.
 86. M. Greenberg and R. Littlewood, “Post-Adoption Incest and Phenotypic Matching: Experience, Personal Meanings and Biosocial Implications,” *British Journal of Medical Psychology* 68 (1995): 29–44. For a collection of reports of this phenomenon in the popular press, see M. Bowerman, “Sexual Attraction to a Long-Lost Parent; Is That a Normal Reaction?,” *USA Today*, August 10, 2016.
 87. Finally, it is conceivable that animals would evolve the capacity to express and recognize signals via what Hamilton called recognition alleles. W. D. Hamilton, “The Genetical Evolution of Social Behaviour,” *Journal of Theoretical Biology* 7 (1964): 17–52. A gene could simultaneously enable its possessor to express a trait, empower the possessor to perceive the trait in others, and endow the possessor with the desire to help those with the trait. Richard Dawkins called this the “green-beard effect,” imagining

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- that such genes might give one a green beard and simultaneously make one partial to others with green beards. It's an appealing idea, but it turns out that there are quite a few conceptual and evolutionary problems with it, including the fact that it would be hard for a single gene (or even a set of genes) to have all of these effects. This mechanism may, however, appear in some microorganisms. R. Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1976). See also S. A. West and A. Gardner, "Altruism, Spite, and Greenbeards," *Science* 327 (2010): 1341–1344.
88. D. Lieberman, J. Tooby, and L. Cosmides, "The Architecture of Human Kin Detection," *Nature* 445 (2007): 727–731. Regarding recognizing siblings, see M. F. Dal Martello and L. T. Maloney, "Where Are Kin Recognition Signals in the Human Face?," *Journal of Vision* 6 (2006): 1356–1366.
 89. G. Palla, A.-L. Barabási, and T. Vicsek, "Quantifying Social Group Evolution," *Nature* 446 (2007): 664–667.
 90. This is known as the ship-of-Theseus problem in philosophy, so called because the Athenians allegedly maintained Theseus's original ship in their harbor for centuries after he returned from killing the Minotaur in Crete, but all of its components were replaced at one point or another. A variation of it is the so-called family-knife problem, a reference to an heirloom knife that has had its handle and blade replaced several times over the centuries.

Chapter 8: Friends and Networks

1. C. Gibbons, "The Victims: Real Movie Heroes Saved Their Sweethearts During Colorado Ambush," *New York Post*, July 22, 2012; H. Yan, "Tales of Heroism Abound from Colorado Movie Theater Tragedy," CNN, July 24, 2012; O. Katrandjian, "Colorado Shooting: Victims Who Died While Saving Their Loved Ones," ABC News, July 22, 2012. During the Thousand Oaks shooting near Los Angeles on November 7, 2018, when a gunman entered a bar and started shooting (ultimately killing a dozen people), many men banded together to try to protect others present. According to one eyewitness who appeared in a video interview, "While we were all dogpiled over on the side, there were multiple men that got on their knees and pretty much blocked all of us, with their back towards the shooter, ready to take a bullet for any single one of us"; see <https://www.goodmorningamerica.com/news/story/multiple-people-injured-reported-mass-shooting-california-bar-59050130>.
2. C. Ng and D. Harris, "Women Who Survived Theater Shooting Grieve for Hero Boyfriends," ABC News, July 24, 2012. See also "Hero Dies Saving Girlfriend in Theater," CNN, July 24, 2012.
3. Yan, "Tales of Heroism."
4. H. Rosin, "In the Aurora Theater the Men Protected the Women. What Does That Mean?," *Slate*, July 23, 2012.
5. For some cases in the news, see M. Wagner, "Buffalo Dad Who Rescued Fiancée, Two Kids from House Fire Dies While Saving Third Child," *New York Daily News*, February 20, 2016; K. French, "Father, 47, Run Over and Killed in Car Crash Saved His Nine-Year-Old Daughter's Life by Shoving Her to Safety," *Daily Mail*, March 17, 2017; D.

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- Prendergast, K. Sheehan, and P. DeGregory, "Mom Dies After Saving Daughter from Out-of-Control Car," *New York Post*, May 14, 2017; and K. Mettler, "She Dived in the Water to Save Her Son," *Washington Post*, August 29, 2016. See also R. Wright, *The Moral Animal* (New York: Vintage, 1995); W. B. Swann et al., "What Makes a Group Worth Dying For? Identity Fusion Fosters Perception of Familial Ties, Promoting Self-Sacrifice," *Journal of Personality Social Psychology* 106 (2014): 912–926; and R. M. Fields and C. Owens, *Martyrdom: The Psychology, Theology, and Politics of Self-Sacrifice* (Westport, CT: Greenwood, 2004).
6. John 15:13–14 (New International Version).
 7. P. Holley, "Zaezion Dobson, High School Football Hero Who Died Shielding Girls from Gunmen, Honored at ESPYS," *Washington Post*, July 13, 2016.
 8. S. Goldstein, "Connecticut Teen Is Fatally Hit by Car While Saving Friend, Unwittingly Completes Bucket List," *New York Daily News*, July 13, 2015.
 9. Tribune Media Wire, "Teen Completes 'Bucket List' by Sacrificing Her Life to Save Friend," WNEP-TV (Moosic, PA) July 14, 2015.
 10. A. Spital, "Public Attitudes Toward Kidney Donation by Friends and Altruistic Strangers in the United States," *Transplantation* 71 (2001): 1061–1064. In the United States, 90 percent of respondents believe friend donation is acceptable, and 80 percent believe stranger donation is acceptable. For friend donations in the news, see C. Watts, "Amy Grant's Daughter Donates Kidney to Best Friend," *USA Today*, January 26, 2017; and A. Wilson, "'Heard Urine Need of a Kidney': Friend Donates Kidney to Man 'Days Away from Failure,'" *Global News*, July 27, 2016. A particularly haunting set of examples of altruism in concentration camps during the Holocaust is provided in A. B. Shostak, *Stealth Altruism: Forbidden Care as Jewish Resistance in the Holocaust* (London: Routledge, 2017). People also risk their lives for complete strangers, and they often do so intuitively. Regarding a sample of fifty-one winners of the Carnegie Hero Fund Commission medal (average age thirty-six, 82 percent male), given to people who act in this way, see D. G. Rand and Z. G. Epstein, "Risking Your Life Without a Second Thought: Intuitive Decision-Making and Extreme Altruism," *PLOS ONE* 9 (2014): e109687.
 11. D. Gilbert, *Stumbling on Happiness* (New York: Knopf, 2006).
 12. D. J. Hruschka, *Friendship: Development, Ecology, and Evolution of a Relationship* (Berkeley: University of California Press, 2010), p. 35. A cynical (and incorrect) account of friendship—one not in keeping with the evidence of friendship relationships in non-human social species or with the reality that an evolutionary account would always ultimately balance the costs and benefits—would assert that friendship is simply a cultural institution that normalizes and justifies an unequal relationship in which someone is always being exploited for someone else's benefit.
 13. Historian Michel Foucault argued that homosexuality might be a way of being friendly, but I see homosexual desire as more similar to heterosexual desire than same-sex friendships. M. Foucault, "Friendship as a Way of Life," in M. Foucault and P. Rabinow, eds., *Essential Works of Foucault, 1954–1984*, vol. 1, *Ethics: Subjectivity and Truth* (New York: New Press, 1997), pp. 135–140.

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14. A. Aron, E. N. Aron, and D. Smollan, "Inclusion of Other in the Self Scale and the Structure of Interpersonal Closeness," *Journal of Personality and Social Psychology* 63 (1992): 596–612.
15. Hruschka, *Friendship*. In some societies, people do not necessarily choose their friends; they sometimes inherit friendships from parents or based on clan ties, or they may have friends recommended by elders. Friendships might also be sealed with public or private rituals, just like weddings.
16. F. Kaplan, "The Idealist in the Bluebonnets: What Bush's Meeting with the Saudi Ruler Really Means," *Slate*, April 26, 2005.
17. Hruschka, *Friendship*, p. 17.
18. S. Perry, "Capuchin Traditions Project," UCLA Department of Anthropology, <http://www.sscnet.ucla.edu/anthro/faculty/sperry/ctp.html>.
19. For instance, in societies characterized by economic and legal unpredictability (such as corrupt states), people are more willing to lie to protect their friends. Hruschka, *Friendship*, p. 186.
20. J. C. Williams, *White Working Class: Overcoming Class Cluelessness in America* (Boston: Harvard Business Review Press, 2017). See also M. Small, *Unanticipated Gains: Origins of Network Inequality in Everyday Life* (Oxford: Oxford University Press, 2009).
21. B. Bigelow, "Children's Friendship Expectations: A Cognitive-Developmental Study," *Child Development* 48 (1977): 246–253.
22. M. Taylor, *Imaginary Companions and the Children Who Create Them* (New York: Oxford University Press, 1999), pp. 30–33. It used to be thought that it was psychologically maladaptive to have imaginary friends, but this is no longer felt to be true. If anything, children with imaginary friends are less shy, more intelligent, and more socially competent than those without.
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24. Just because friendships may not necessarily feel like reciprocal relationships *proximately* does not mean that *ultimately* they do not have this origin.
25. J. Tooby and L. Cosmides, "Friendship and the Banker's Paradox: Other Pathways to the Evolution of Adaptations for Altruism," *Proceedings of the British Academy* 88 (1996): 119–143.
26. *Ibid.*, p. 132.
27. Hruschka, *Friendship*; R. M. Seyfarth and D. L. Cheney, "The Evolutionary Origins of Friendship," *Annual Review of Psychology* 63 (2012): 153–177. See also A. Burt, "A Mechanistic Explanation of Popularity: Genes, Rule Breaking, and Evocative Gene-Environment Correlations," *Journal of Personality and Social Psychology* 96 (2009): 783–794; G. Guo, "Genetic Similarity Shared by Best Friends Among Adolescents," *Twin Research and Human Genetics* 9 (2006): 113–121; J. H. Fowler, C. T. Dawes, and N. A. Christakis, "Model of Genetic Variation in Human Social Networks," *PNAS: Proceedings of the National Academy of Sciences* 106 (2009): 1720–1724; J. D. Boardman, B. W. Domingue, and J. M. Fletcher, "How Social and Genetic Factors Predict Friendship Networks," *PNAS: Proceedings of the National Academy of Sciences* 109 (2012): 17377–17381; and M.

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28. Fowler, Dawes, and Christakis, "Model of Genetic Variation."
 29. Tooby and Cosmides, "Friendship and the Banker's Paradox," p. 137.
 30. M. McPherson, L. Smith-Lovin, and J. M. Cook, "Birds of a Feather: Homophily in Social Networks," *Annual Review of Sociology* 27 (2001): 415–444.
 31. C. Parkinson, A. M. Kleinbaum, and T. Wheatley, "Similar Neural Responses Predict Friendship," *Nature Communications* 9 (2018): 332.
 32. N. A. Christakis and J. H. Fowler, "Friendship and Natural Selection," *PNAS: Proceedings of the National Academy of Sciences* 111 (2014): 10796–10801. Regarding homophily in other species, see D. Lusseau and M. E. J. Newman, "Identifying the Role That Animals Play in Their Social Networks," *Proceedings of the Royal Society B* 271 (2004): S477–S481; L. J. H. Brent, J. Lehmann, and G. Ramos-Fernández, "Social Network Analysis in the Study of Nonhuman Primates: A Historical Perspective," *American Journal of Primatology* 73 (2011): 720–730.
 33. L. M. Guth and S. M. Roth, "Genetic Influence on Athletic Performance," *Current Opinion in Pediatrics* 25 (2013): 653–658.
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 35. Homophily evolves under a much wider variety of conditions than heterophily, even when the fitness advantage to dissimilarity exceeds the fitness advantage to similarity. F. Fu, M. A. Nowak, N. A. Christakis, and J. H. Fowler, "The Evolution of Homophily," *Scientific Reports* 2 (2012): 845.
 36. Christakis and Fowler, "Friendship and Natural Selection." See also B. W. Domingue, D. W. Belsky, J. M. Fletcher, D. Conley, J. D. Boardman, and K. M. Harris, "The Social Genome of Friends and Schoolmates in the National Longitudinal Study of Adolescent to Adult Health," *PNAS: Proceedings of the National Academy of Sciences* 115 (2018): 702–707; and J. H. Fowler, J. E. Settle, and N. A. Christakis, "Correlated Genotypes in Friendship Networks," *PNAS: Proceedings of the National Academy of Sciences* 108 (2011): 1993–1997.
 37. A one-standard-deviation change in the friendship score can explain approximately 1.4 percent of the variance in the existence of friendship ties. Christakis and Fowler, "Friendship and Natural Selection." This is similar to the variance explained using the best currently available genetic scores for schizophrenia and bipolar disorder (0.4 percent to 3.2 percent) and body mass index (1.5 percent). For comparison, see S. M. Purcell et al., "Common Polygenic Variation Contributes to Risk of Schizophrenia and Bipolar Disorder," *Nature* 460 (2009): 748–752; and E. K. Speliotes et al., "Association Analyses of 249,796 Individuals Reveal 18 New Loci Associated with Body Mass Index," *Nature Genetics* 42 (2010): 937–948.
 38. D. Lieberman, J. Tooby, and L. Cosmides, "The Architecture of Human Kin Detection," *Nature* 445 (2007): 727–731.
 39. In fact, the customs related to fictive kin seen in so many societies comport with this idea; humans pick compadres, have godparents and "aunties," fight side by side with brothers-in-arms, and call their friends by kin terms such as "bro" or "sis."

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40. E. Herrmann et al., “Humans Have Evolved Specialized Skills of Social Cognition: The Cultural Intelligence Hypothesis,” *Science* 317 (2007): 1360–1366.
41. Such an effect would especially speed up the evolution of phenotypes that are intrinsically synergistic, and this may help shed light on the observation that evolution in humans is accelerating. J. Hawks, E. T. Wang, G. M. Cochran, H. C. Harpending, and R. K. Moyzis, “Recent Acceleration of Human Adaptive Evolution,” *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 20753–20758.
42. W. D. Hamilton, “Innate Social Aptitudes of Man: An Approach from Evolutionary Genetics,” in R. Fox, ed., *Biosocial Anthropology* (London: Malaby Press, 1975), pp. 133–153; J. M. Smith, “Group Selection,” *Quarterly Review of Biology* 51 (1976): 277–283.
43. H. B. Shakya, N. A. Christakis, and J. H. Fowler, “An Exploratory Comparison of Name Generator Content: Data from Rural India,” *Social Networks* 48 (2017): 157–168. There are, obviously, many other questions one can use to identify all sorts of specialized or minor connections, such as “Who do you play sports with?” and “Who do you ask for health advice?”
44. A. J. O’Malley, S. Arbesman, D. M. Steiger, J. H. Fowler, and N. A. Christakis, “Egocentric Social Network Structure, Health, and Pro-Social Behaviors in a National Panel Study of Americans,” *PLOS ONE* 7 (2012): e36250. This corresponds with prior work; see P. V. Marsden, “Core Discussion Networks of Americans,” *American Sociological Review* 52 (1987): 122–131; M. McPherson, L. Smith-Lovin, and M. E. Brashears, “Social Isolation in America: Changes in Core Discussion Networks over Two Decades,” *American Sociological Review* 71 (2006): 353–375. People understandably include spouses and siblings when answering these questions, so if we want to identify strictly unrelated friends, it helps to remove those individuals from the list.
45. The panels in this figure are as follows: (a) A gift network among 91 men in the Nyan-gatom people of Sudan (the ties indicate who would give an anonymous gift to whom); 34 ties are family ties (to siblings) and 239 are friendship connections. (b) Another gift network among 96 men residing in a village in Uganda; 35 ties are family ties, and 151 are friendship ties. (c) A network of 103 women among the Hadza people of Tanzania, based on whom the women said they would ideally like to share camp with in the future; 179 ties are family ties, and 183 are friendship ties. (d) A rural village in Honduras with 216 people (78 men and 138 women); 235 ties are family ties, and 505 are friendship ties. Men and women seem well mixed in this village (the blue and red dots, respectively, are interspersed). Also note that if a line was drawn from approximately where one o’clock would be on a clock face to about where seven o’clock would be, the village would seem to be divisible into two social communities (with more ties within each community than between them). (e) A rural village in Uganda with 261 people (121 men and 140 women); 173 ties are family ties, and 657 are friendship ties. Note the relative separation of men and women in this village (the blue and red dots are not as uniformly interspersed, meaning that men tend to socialize with men, and women with women). (f) A rural village in India with 214 people (95 men and 119 women); 107 ties are family ties, and 569 are friendship ties. Men and women are socially segregated here too, into clusters of blue and red dots. All of these data are from our own data-collection efforts and published papers,

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- except for the Indian village network (for which the raw data were collected by others). See L. Glowacki, A. Isakov, R. W. Wrangham, R. McDermott, J. H. Fowler, and N. A. Christakis, "Formation of Raiding Parties for Intergroup Violence Is Mediated by Social Network Structure," *PNAS: Proceedings of the National Academy of Sciences* 113 (2016): 12114–12119; J. M. Perkins et al., "Food Insecurity, Social Networks and Symptoms of Depression Among Men and Women in Rural Uganda: A Cross-Sectional, Population-Based Study," *Public Health Nutrition* 21 (2018): 838–848; C. L. Apicella, F. W. Marlowe, J. H. Fowler, and N. A. Christakis, "Social Networks and Cooperation in Hunter-Gatherers," *Nature* 481 (2012): 497–501; H. N. Shakya et al., "Exploiting Social Influence to Magnify Population-Level Behaviour Change in Maternal and Child Health: Study Protocol for a Randomised Controlled Trial of Network Targeting Algorithms in Rural Honduras," *BMJ Open* 7 (2017): e012996; H. B. Shakya, N. A. Christakis, and J. H. Fowler, "Social Network Predictors of Latrine Ownership," *Social Science and Medicine* 125 (2015): 129–138. Slightly different name generators to identify important social ties were used for the villages in Honduras, Uganda, and India, but in general, the ties were defined based on whom people said they would get social support from or spend time with. Sometimes, such people were also family members (shown in orange ties between the nodes), but most of the time they were not close family (shown in gray ties).
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 47. Apicella et al., "Social Networks and Cooperation."
 48. C. M. Rawlings and N. E. Friedkin, "The Structural Balance Theory of Sentiment Networks: Elaboration and Test," *American Journal of Sociology* 123 (2017): 510–548.
 49. S. Sampson, "Crisis in a Cloister" (PhD diss., Cornell University, 1969).
 50. For studies of bullying involving sociocentric network mapping, see C. Salmivalli, A. Huttunen, and K. M. J. Lagerspetz, "Peer Networks and Bullying in Schools," *Scandinavian Journal of Psychology* 38 (1997): 305–312; and G. Huitsing and R. Veenstra, "Bullying in Classrooms: Participant Roles from a Social Network Perspective," *Aggressive Behavior* 38 (2012): 494–509. Regarding workplaces, see, for example, L. Xia, Y. C. Yuan, and G. Gay, "Exploring Negative Group Dynamics: Adversarial Network, Personality, and Performance in Project Groups," *Management Communication Quarterly* 23 (2009): 32–62; A. Gerbasi, C. L. Porath, A. Parker, G. Spreitzer, and R. Cross, "Destructive De-Energizing Relationships: How Thriving Buffers Their Effect on Performance," *Journal of Applied Psychology* 100 (2015): 1423–1433; and G. Labianca and D. J. Brass, "Exploring the Social Ledger: Negative Relationships and Negative Asymmetry in Social Networks in Organizations," *Academy of Management Review* 31 (2006): 596–614.
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- Online World,” *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 13636–13641. For another example of negative ties in an online network, see G. Faccetti, G. Iacono, and C. Altafini, “Computing Global Structural Balance in Large-Scale Signed Social Networks” *PNAS: Proceedings of the National Academy of Sciences* 108 (2011): 20953–20958.
52. Shakya et al., “Exploiting Social Influence.” Our work on antagonistic ties is described in A. Isakov, J. H. Fowler, E. M. Airoidi, and N. A. Christakis, “The Structure of Negative Ties in Human Social Networks” (unpublished manuscript, 2018).
53. According to the World Bank, the murder rate in Honduras peaked at 93.2 per 100,000 in 2011, declining to 74.6 per 100,000 in 2014. For comparison, other country statistics are as follows: United States, 3.9 per 100,000 in 2013; United Kingdom, 0.9 per 100,000 in 2013; and Russian Federation, 9.5 per 100,000 in 2014. “Intentional Homicides (per 100,000 People),” World Bank, https://data.worldbank.org/indicator/VC.IHR.PSRC.P5?year_high_desc=false.
54. The standard deviation of this measure was 2.6.
55. The standard deviation was 1.2.
56. The standard deviation was 1.3.
57. G. Simmel, *The Sociology of Georg Simmel* (New York: Simon and Schuster, 1950); F. Heider, “Attitudes and Cognitive Organization,” *Journal of Psychology* 21 (1946): 107–112; D. Cartwright and F. Harary, “Structural Balance: A Generalization of Heider’s Theory,” *Psychology Review* 63 (1956): 277–293. The earliest known exposition of the claim that the “enemy of my enemy is my friend” appears to be from the fourth century BCE. L. N. Rangarajan, *The Arthashastra* (New Delhi: Penguin Books India, 1992), p. 520.
58. A. Rapoport, “Mathematical Models of Social Interaction,” in R. A. Galanter, R. R. Luce, and E. Bush, eds., *Handbook of Mathematical Sociology*, vol. 2 (New York: John Wiley and Sons, 1963), 493–580.
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60. “Paul Klee and Wassily Kandinsky,” Wassily Kandinsky: Biography, Paintings, and Quotes, Wassily-Kandinsky.org, 2011, <http://www.wassily-kandinsky.org/kandinsky-and-paul-klee.jsp>.
61. M. Billig and H. Tajfel, “Social Categorization and Similarity in Intergroup Behaviour,” *European Journal of Social Psychology* 3 (1973): 27–55.
62. Tajfel et al., “Social Categorization.”
63. T. Yamagishi, N. Jin, and T. Kiyonari, “Bounded Generalized Reciprocity: Ingroup Boasting and Ingroup Favoritism,” *Advances in Group Processes* 16 (1999): 161–197.
64. Experiments show that if rewards do *not* depend on the behaviors of others in the group, people do not show in-group favoritism. J. M. Rabbie and H. F. M. Lodewijkx, “Conflict and Aggression: An Individual-Group Continuum,” *Advances in Group Processes* 11 (1994): 139–174.
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- Hamilton); market interactions; reciprocity based on serial interactions; decentralized enforcement, including via social norms; reputation effects; and group selection.
66. M. B. Brewer, "The Psychology of Prejudice: Ingroup Love or Outgroup Hatred?," *Journal of Social Issues* 55 (1999): 429–444.
 67. M. Sherif, O. J. Harvey, B. J. White, W. R. Hood, and C. W. Sherif, *Intergroup Conflict and Cooperation: The Robbers Cave Experiment* (Norman: Institute of Group Relations, University of Oklahoma, 1961). It appears that the experiments reported in this study were not the first ones Sherif conducted; another group of boys did not perform as expected, and Sherif rejected the results. G. Perry, *The Lost Boys: Inside Muzafer Sherif's Robbers Cave Experiment* (Melbourne: Scribe, 2018).
 68. Sherif et al., *Intergroup Conflict*, p. 98.
 69. *Ibid.*, p. 151.
 70. *Ibid.*
 71. Something similar happened on the evening of September 11, 2001, when one hundred and fifty members of Congress from both parties gathered on the steps of the Capitol and sang "God Bless America." "The Singing of 'God Bless America' on September 11, 2001," History, Art and Archives, U.S. House of Representatives, <http://history.house.gov/HistoricalHighlight/Detail/36778>.
 72. W. G. Sumner, *Folkways: A Study of the Sociological Importance of Usages, Manners, Customs, Mores, and Morals* (Boston: Ginn, 1906), pp. 12–13.
 73. The killing of conspecifics is also rare in animals. See J. M. Gomez, M. Verdo, A. Gonzalez-Negras, and M. Mendez, "The Phylogenetic Roots of Human Lethal Violence," *Nature* 538 (2016): 233–237.
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 76. F. Fu, C. E. Tarnita, N. A. Christakis, L. Wang, D. G. Rand, and M. A. Nowak, "Evolution of Ingroup Favoritism," *Scientific Reports* 2 (2012): 460.
 77. This story is told in R. M. Sapolsky, *Behave: The Biology of Humans at Our Best and Worst* (New York: Penguin, 2017), p. 409. Armistead died at the hospital, alas.
 78. Y. Dunham, E. E. Chen, and M. R. Banaji, "Two Signatures of Implicit Intergroup Attitudes: Developmental Invariance and Early Enculturation," *Psychological Science* 24 (2013): 860–868; Y. Dunham, A. S. Baron, and M. R. Banaji, "The Development of Implicit Intergroup Cognition," *Trends in Cognitive Sciences* 12 (2008): 248–253. The role of enculturation is also clearly important.
 79. A. V. Shkurko, "Is Social Categorization Based on Relational Ingroup/Outgroup Opposition? A Meta-Analysis," *Social Cognitive and Affective Neuroscience* 8 (2013): 870–877.
 80. M. B. Brewer, "The Psychology of Prejudice: Ingroup Love or Outgroup Hatred?," *Journal of Social Issues* 55 (1999): 429–444.

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81. Yamagishi, Jin, and Kiyonari, "Bounded Generalized Reciprocity," p. 173.
82. G. Allport, *The Nature of Prejudice* (Reading, MA: Addison-Wesley, 1954), p. 42.
83. In-group bias can even subvert the impact of sharing superordinate goals. Even if people do share superordinate goals with an out-group, it does not necessarily lead to holding positive views of them, let alone offering them kindness, because the in-group might still project in-group expectations onto this larger group. All that might be achieved is that the in-group would judge out-group individuals as simply bad members of the superordinate group to which everyone now belongs.
84. H. C. Triandis, *Individualism and Collectivism* (Boulder, CO: Westview Press, 1995).
85. C. Lévi-Strauss, *Structural Anthropology*, trans. C. Jacobson and B. G. Schoepf (New York: Basic Books, 1967). Incidentally, the way humans see social opposition as binary ("us" versus "them") helps explain why we are entertained and confounded by more complex competitive interactions in fiction, such as the three-way gunfight in *The Good, the Bad, and the Ugly* and the five-way contest among the armies in *The Hobbit: The Battle of the Five Armies*.
86. R. W. Emerson, *Essays and English Traits by Ralph Waldo Emerson* (1841; New York: Cosimo Classics, 1909), pp. 109–124.
87. Hruschka, *Friendship*.

Chapter 9: One Way to Be Social

1. A. Starr and M. L. Edwards, "Mitral Replacement: Clinical Experience with a Ball-Valve Prosthesis," *Annals of Surgery* 154 (1961): 726–740.
2. J. P. Binet, A. Carpentier, J. Langlois, C. Duran, and P. Colvez, "Implantation de valves hétérogènes dans le traitement des cardiopathies aortiques," *Comptes rendus des séances de l'Académie des sciences. Série D, Sciences naturelles* 261 (1965): 5733–5734.
3. Artists and storytellers have explored the unnerving nature of human-animal hybrids for a very long time, at least as far back as the Chimera of Greek mythology. But modern science has had its own fixation with hybrids: animal-to-human blood transfusions in the seventeenth century, the first xenotransplantation of a pig cornea to a human in 1838, the insertion of a baboon heart into the newborn Baby Fae in 1984, and the successful integration of human stem cells into a growing pig embryo in 2017. D. K. C. Cooper, "A Brief History of Cross-Species Organ Transplantation," *Baylor University Medical Center Proceedings* 25 (2012): 49–57; K. Reemtsma, "Xenotransplantation: A Historical Perspective," *Institute for Laboratory Animal Research Journal* 37 (1995): 9–12.
4. B. Hölldobler and E. O. Wilson, *The Ants* (Cambridge, MA: Harvard University Press, 1990).
5. Several members of the family Bathyergidae, which includes the naked mole rat, the Damaraland mole rat, and others, can be considered eusocial. It is possible that certain social voles may also exhibit eusocial behaviors. H. Burda, R. L. Honeycutt, S. Begall, O. Locker-Grütjen, and A. Scharff, "Are Naked and Common Mole-Rats Eusocial and If So, Why?," *Behavioral Ecology and Sociobiology* 47 (2000): 293–303.
6. An additional technical criterion for eusociality is that there are overlapping generations in the colony. Eusociality has evolved independently in several insect taxa, including bees, wasps, ants, and termites; in coral-reef shrimp (where it has evolved

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- several times!); and in mammals such as mole rats (which is a fascinating exception). *Eusocial* is defined as a form of social organization that involves three properties: cooperative care of offspring, overlapping generations, and a division of labor into reproductive and nonreproductive subgroups of the population.
7. M. dos Reis, J. Inoue, M. Hasegawa, R. J. Asher, P. C. J. Donoghue, and Z. Yang, "Phylogenomic Datasets Provide Both Precision and Accuracy in Estimating the Time-scale of Placental Mammal Phylogeny," *Proceedings of the Royal Society B* 279 (2012): 3491–3500. These estimates are necessarily imprecise; for instance, the point of divergence between humans and chimpanzees is thought to have occurred sometime between thirteen and four million years ago.
 8. J. Parker, G. Tsagkogeorga, J. A. Cotton, Y. Liu, P. Provero, E. Stupka, and S. J. Rositter, "Genome-Wide Signatures of Convergent Evolution in Echolocating Mammals," *Nature* 502 (2013): 228–231. In the case of echolocation, we know that genes used for the convergent phenotypes may be similar across widely divergent taxa, such as bats and dolphins.
 9. S. C. Morris, *Life's Solution: Inevitable Humans in a Lonely Universe* (Cambridge: Cambridge University Press, 2003), p. 128.
 10. *Ibid.*
 11. *Ibid.*, p. 248.
 12. S. Gould, *Wonderful Life: The Burgess Shale and the Nature of History* (New York: W. W. Norton, 1990).
 13. One interesting question about personality is why the personality of individuals varies little over time and yet there is so much variation between individuals. See, for example, M. Wolf, G. S. van Doorn, O. Leimar, and F. J. Weissing, "Life-History Trade-Offs Favour the Evolution of Animal Personalities," *Nature* 447 (2007): 581–584; and M. Wolf and F. J. Weissing, "An Explanatory Framework for Adaptive Personality Differences," *Philosophical Transactions of the Royal Society B* 365 (2010): 3959–3968.
 14. M. J. Sheehan and M. W. Nachman, "Morphological and Population Genomic Evidence That Human Faces Have Evolved to Signal Individual Identity," *Nature Communications* 5 (2014): 4800. See also G. Yovel and W. A. Freiwald, "Face Recognition Systems in Monkey and Human: Are They the Same Thing?," *F1000Prime Reports* 5 (2013): 10.
 15. C. Schlitz et al., "Impaired Face Discrimination in Acquired Prosopagnosia Is Associated with Abnormal Response to Individual Faces in the Right Middle Fusiform Gyrus," *Cerebral Cortex* 16 (2006): 574–586; P. Shah, "Identification, Diagnosis and Treatment of Prosopagnosia," *British Journal of Psychiatry* 208 (2016): 94–95.
 16. E. Prichard, "Prosopagnosia: How Face Blindness Means I Can't Recognize My Mum," *BBC News Magazine*, July 1, 2016.
 17. Sheehan and Nachman, "Morphological and Population Genomic Evidence."
 18. In principle, such cues could also be acquired, like barnacles on a whale's tail or rips in an elephant's ears that come to be unique and identifiable.
 19. Examples of individual recognition (especially beyond mating pairs) are exceedingly rare outside of mammals and birds. R. W. Wrangham, "Social Relationships in Com-

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- parative Perspective,” in R. A. Hinde, ed., *Primate Social Relationships: An Integrated Approach* (Oxford: Blackwell, 1983), pp. 325–334; P. d’Etorre, “Multiple Levels of Recognition in Ants: A Feature of Complex Societies,” *Biological Theory* 3 (2008): 108–113. Regarding cooperation, see J. M. McNamara, Z. Barta, and A. I. Houston, “Variation in Behaviour Promotes Cooperation in the Prisoner’s Dilemma Game,” *Nature* 428 (2004): 745–748; and S. F. Brosnan, L. Salwiczek, and R. Bshary, “The Interplay of Cognition and Cooperation,” *Philosophical Transactions of the Royal Society B* 365 (2010): 2699–2710.
20. Travelers to Xian, China, can find startling evidence of human facial diversity; scientists believe that each one of the thousands of famous terra-cotta warriors there features a unique set of ears, likely evidence that the statues were modeled on individual human soldiers. E. Quill, “Were the Terracotta Warriors Based on Actual People?,” *Smithsonian*, March 2015.
 21. Interestingly, faces generally vary only slightly from side to side, and facial symmetry is often viewed as a marker of beauty. B. C. Jones et al., “Facial Symmetry and Judgments of Apparent Health,” *Evolution and Human Behavior* 22 (2001): 417–429; K. Grammer and R. Thornhill, “Human (*Homo sapiens*) Facial Attractiveness and Sexual Selection: The Role of Symmetry and Averageness,” *Journal of Comparative Psychology* 108 (1994): 233–242; J. E. Scheib, S. W. Gangestad, and R. Thornhill, “Facial Attractiveness, Symmetry and Cues of Good Genes,” *Proceedings of the Royal Society B* 266 (1999): 1913–1917.
 22. Sheehan and Nachman, “Morphological and Population Genomic Evidence.”
 23. J. Freund et al., “Emergence of Individuality in Genetically Identical Mice,” *Science* 340 (2013): 756–759.
 24. One such advantage might be to communicate how cooperative someone is, and there is evidence that adult humans can make instantaneous, intuitive, and accurate decisions about how likely other people are to reciprocate generosity based solely on their faces. See J. F. Bonnefon, A. Hopfensitz, and W. De Neys, “Can We Detect Cooperators by Looking at Their Face?,” *Current Directions in Psychological Science* 26 (2017): 276–281.
 25. R. A. Hinde, “Interactions, Relationships and Social Structure,” *Man* 11 (1976): 1–17.
 26. J. van Lawick–Goodall, *In the Shadow of Man* (Boston: Houghton Mifflin, 1971).
 27. L. A. Parr, “The Evolution of Face Processing in Primates,” *Philosophical Transactions of the Royal Society B* 366 (2011): 1764–1777.
 28. L. A. Parr, J. T. Winslow, W. D. Hopkins, and F. B. de Waal, “Recognizing Facial Cues: Individual Discrimination by Chimpanzees (*Pan troglodytes*) and Rhesus Monkeys (*Macaca mulatta*),” *Journal of Comparative Psychology* 114 (2000): 47–60. See also S. A. Rosenfeld and G. W. Van Hoesen, “Face Recognition in the Rhesus Monkey,” *Neuropsychologia* 17 (1979): 503–509.
 29. J. A. Pineda, G. Sebestyen, and C. Nava, “Face Recognition as a Function of Social Attention in Non-Human Primates: An ERP Study,” *Cognitive Brain Research* 2 (1994): 1–12.
 30. L. A. Parr, M. Heintz, E. Lonsdorf, and E. Wroblewski, “Visual Kin Recognition in Nonhuman Primates (*Pan troglodytes* and *Macaca mulatta*): Inbreeding Avoidance or Male Distinctiveness?,” *Journal of Comparative Psychology* 124 (2010): 343–350; C. Almstrom

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38. G. G. Gallup, M. K. McClure, S. D. Hill, and R. A. Bundy, “Capacity for Self-Recognition in Differentially Reared Chimpanzees,” *Psychological Record* 21 (1971): 69–74.
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41. R. Cohn, *Michael’s Story, Where He Signs About His Family* (KokoFlix, March 23, 2008), video recording, <https://www.youtube.com/watch?v=DXKsPqQ0Ycc>. See also R. Morin, “A Conversation with Koko the Gorilla,” *Atlantic*, August 28, 2015.
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64. "World: South Asia Elephant Dies of Grief," BBC News, May 6, 1999, http://news.bbc.co.uk/2/hi/south_asia/337356.stm.
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88. Henrich et al., "Costly Punishment." These authors also argue that there might be an effect of these cultural norms on the *genetic* basis for altruistic behaviors *across* populations, reflecting gene-culture coevolution (see chapter 11). Local punishment behaviors can create social environments favoring the genetic evolution of psychological traits that predispose people to administer, anticipate, and avoid punishment.
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93. This cyclical pattern has been called Red Queen dynamics, a reference to a character in Lewis Carroll's *Through the Looking-Glass*. When Alice remarks that where she's from, if you ran very fast for a long time, you'd get somewhere, the Red Queen responds, "A slow sort of country! ... Now, *here*, you see, it takes all the running you can do, to keep in the same place."
94. These mathematical models of evolution, therefore, yield an important insight about how punishment could have arisen. The existence of the option of being a loner would drive everyone but cooperators and punishers to extinction, and then, with no defectors left requiring costly punishment, punishers could emerge and survive (and reap the same rewards as the cooperators). J. H. Fowler, "Altruistic Punishment and

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114. B. Kenward et al., "Behavioural Ecology: Tool Manufacture by Naïve Juvenile Crows," *Nature* 433 (2005): 121. Regional variation in the shape of crow tools may also reflect cumulative cultural evolution.
115. K. N. Laland and V. M. Janik, "The Animal Culture Debate," *Trends in Ecology and Evolution* 21 (2006): 542–547.
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124. D. Wroclavsky, "Killer Whales Bring the Hunt onto Land," Reuters, April 17, 2008, <https://www.reuters.com/article/us-argentina-orcas-feature-idUSMAR71901420080417?src=RSS-SCI>.
125. H. Whitehead and L. Rendell, *The Cultural Lives of Whales and Dolphins* (Chicago: University of Chicago Press, 2014).
126. E. J. C. van Leewen, K. A. Cronin, and D. B. M. Haun, "A Group-Specific Arbitrary Tradition in Chimpanzees (*Pan troglodytes*)," *Animal Cognition* 17 (2014): 1421–1425.
127. D. Kim et al., "Social Network Targeting to Maximise Population Behaviour Change: A Cluster Randomised Controlled Trial," *Lancet* 386 (2015): 145–153.
128. To be clear, there are other ways that useless or even harmful practices could be maintained in a population. For instance, if punishment is possible, even fitness-lowering behaviors can be sustained. See R. Boyd and P. J. Richerson, "Punishment Allows the Evolution of Cooperation (or Anything Else) in Sizable Groups," *Ethology and Sociobiology* 13 (1992): 171–195.

Chapter 10: Remote Control

1. D. Attenborough, *Animal Behavior of the Australian Bowerbird*, BBC Studios, February 9, 2007, <https://www.youtube.com/watch?v=GPbWJPsBPdA>. In the clip, Attenborough notes that he is in New Guinea, not Australia.
2. R. O. Prum, *The Evolution of Beauty: How Darwin's Forgotten Theory of Mate Choice Shapes the Animal World—and Us* (New York: Doubleday, 2017), p. 188.
3. J. Diamond, "Animal Art: Variation in Bower Decorating Style Among Male Bowerbirds *Amblyornis inornatus*," *PNAS: Proceedings of the National Academy of Sciences* 83 (1986): 3042–3046.
4. L. A. Kelly and J. A. Ender, "Male Great Bowerbirds Create Forced Perspective Illusions with Consistently Different Individual Quality," *PNAS Proceedings of the National Academy of Sciences* 109 (2012): 20980–20985.
5. Prum, *Evolution of Beauty*, p. 199.
6. In 2005, James Fowler and I were exploring how depression might spread among interconnected people in a social network, which we eventually published as J. N. Rosenquist, J. H. Fowler, and N. A. Christakis, "Social Network Determinants of

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- Depression,” *Molecular Psychiatry* 16 (2011): 273–281. In the course of doing that work, we became familiar with the way that psychiatrists think about phenotypes, because, for psychiatrists, phenotypes are not necessarily visible and can be quite subtle. Psychiatrists use the term *endophenotype* to refer to an intermediate, internal phenotype that is on the causal path to a more apparent one. For, example, people who manifest bipolar disorder may have difficulty with face perception, which may be traced to a disorder in the function of at least one gene; that difficulty is the endophenotype. So, in thinking about that topic, it occurred to us that there could also be exophenotypes. The term *endophenotype* was originally coined by Bernard John and Kenneth Lewis with respect to grasshoppers who looked morphologically the same but who manifested different behaviors. B. John and K. R. Lewis, “Chromosome Variability and Geographic Distribution in Insects,” *Science* 152 (1966): 711–721.
7. R. Dawkins, *The Extended Phenotype: The Long Reach of the Gene* (Oxford: W. H. Freeman, 1982), p. vi.
 8. Writing in 1982, Dawkins noted that there was scant evidence for this argument and that his book should be seen as a work of “advocacy.” *Ibid.*, p. vii. One of the most humbling but also reassuring experiences you can have as a scientist is to realize that you are not the first one to have a particular idea.
 9. *Ibid.* Dawkins returned to this topic twenty years later. R. Dawkins, “Extended Phenotype—But Not Too Extended: A Reply to Laland, Turner, and Jablonka,” *Biology and Philosophy* 19 (2004): 377–396.
 10. H. Eiberg et al., “Blue Eye Color in Humans May Be Caused by a Perfectly Associated Founder Mutation in a Regulatory Element Located Within the *HERC2* Gene Inhibiting *OCA2* Expression,” *Human Genetics* 123 (2008): 177–187. This blue color is not ascribable to a blue pigment but to the way the substances in the eye are physically structured (the same way that peacock feather pigments are all actually brown, but they scatter light in ways that make them appear blue or green).
 11. *Ibid.* See also J. J. Negro, M. C. Blázquez, and I. Galván, “Intraspecific Eye Color Variability in Birds and Mammals: A Recent Evolutionary Event Exclusive to Humans and Domestic Animals,” *Frontiers in Zoology* 14 (2017): 53.
 12. See, for example, R. N. Frank, J. E. Puklin, C. Stock, and L. A. Canter, “Race, Iris Color, and Age-Related Macular Degeneration,” *Transactions of the American Ophthalmological Society* 98 (2000): 109–117; and R. Ferguson et al., “Genetic Markers of Pigmentation Are Novel Risk Loci for Uveal Melanoma,” *Scientific Reports* 6 (2016): 31191.
 13. Anthropologist John Hawks notes that, ten thousand years ago, nobody had blue eyes. Considering the large population of blue-eyed individuals that exist now, it raises the question of why blue-eyed people have a perhaps 5 percent advantage in reproducing compared with non-blue-eyed people. J. Hawks et al., “Recent Acceleration of Human Adaptive Evolution,” *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 20753–20758.
 14. D. Peshek, N. Semmaknejad, D. Hoffman, and P. Foley, “Preliminary Evidence That the Limbal Ring Influences Facial Attractiveness,” *Evolutionary Psychology* 9 (2011): 137–146.

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15. However, brown-eyed people were perceived as more trustworthy in one study. K. Kleisner, L. Priplatova, P. Frost, and J. Flegr, "Trustworthy-Looking Face Meets Brown Eyes," *PLOS ONE* 8 (2013): e53285.
16. Dawkins, "Extended Phenotype."
17. Housing architecture belongs to the realm of culture; however, architecture might affect our evolution by other means, a process known as gene-culture coevolution, discussed in chapter 11.
18. I. Arndt and J. Tautz, *Animal Architecture* (New York: Harry N. Abrams, 2014); M. Hansell, *Built by Animals: The Natural History of Animal Architecture* (Oxford: Oxford University Press, 2007).
19. T. A. Blackledge, N. Scharff, J. A. Coddington, T. Szűts, J. W. Wenzel, C. Y. Hayashi, and I. Agnarssona, "Reconstructing Web Evolution and Spider Diversification in the Molecular Era," *PNAS: Proceedings of the National Academy of Sciences* 106 (2009): 5229–5234. The evolution and origin of webs across Araneae is still in dispute. J. E. Garb, T. DiMauro, V. Vo, and C. Y. Hayashi, "Silk Genes Support the Single Origin of Orb Webs," *Science* 312 (2006): 1762. Webs are differentiated not only by their architecture but also by features such as ultraviolet reflection (less reflection of ultraviolet light makes the webs harder for prey to see), stickiness, fiber strength, and tension-maintaining mechanisms.
20. The concept of an adaptive radiation was most famously illustrated by Charles Darwin, who, during his voyage to the Galápagos Islands in 1835, observed that finches had different sorts of beaks depending on the food sources available at their locations in the islands—thick beaks to break the coverings of seeds, thin ones to get nectar from cactuses. A gene known as *Alx1* varies in its type across the species, affecting the shape of their beaks. S. Lamichhaney et al., "Evolution of Darwin's Finches and Their Beaks Revealed by Genome Sequencing," *Nature* 518 (2015): 371–375. Incidentally, this same gene is known to affect facial features in mice and humans. In the case of spiderwebs, of course, it's not a body part that varies but an external artifact.
21. Species with drab plumage often have more elaborate bowers, while species with colorful plumage tend to build less impressive bowers, as if some species over time have shifted from emphasizing physical phenotypes to emphasizing behavioral exophenotypes. Dawkins, *Extended Phenotype*, p. 199.
22. J. N. Weber, B. K. Peterson, and H. E. Hoekstra, "Discrete Genetic Modules Are Responsible for Complex Burrow Evolution in *Peromyscus* Mice," *Nature* 493 (2013): 402–405.
23. D. P. Hughes, "On the Origins of Parasite Extended Phenotypes," *Integrative and Comparative Biology* 54 (2014): 210–217.
24. W. M. Ingram, L. M. Goodrich, E. A. Robey, and M. B. Eisen, "Mice Infected with Low-Virulence Strains of *Toxoplasma gondii* Lose Their Innate Aversion to Cat Urine, Even After Extensive Parasite Clearance," *PLOS ONE* 8 (2013): e75246.
25. D. G. Biron, F. Ponton, C. Joly, A. Menigoz, B. Hanelt, and F. Thomas, "Water-Seeking Behavior in Insects Harboring Hairworms: Should the Host Collaborate?," *Behavioral Ecology* 16 (2005): 656–660.

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26. S. A. Adamo, "The Strings of the Puppet Master: How Parasites Change Host Behavior," in D. P. Hughes, J. Brodeur, and F. Thomas, eds., *Host Manipulation by Parasites* (Oxford: Oxford University Press, 2012), pp. 36–53.
27. M. A. Fredericksen et al., "Three-Dimensional Visualization and a Deep-Learning Model Reveal Complex Fungal Parasite Networks in Behaviorally Manipulated Ants," *PNAS: Proceedings of the National Academy of Sciences* 114 (2017): 12590–12595.
28. D. P. Hughes, T. Wappler, and C. C. Labandeira, "Ancient Death-Grip Leaf Scars Reveal Ant-Fungal Parasitism," *Biology Letters* 7 (2011): 67–70.
29. T. R. Sampson and S. K. Mazmanian, "Control of Brain Development, Function, and Behavior by the Microbiome," *Cell Host and Microbe* 17 (2015): 565–576.
30. A. D. Blackwell et al., "Helminth Infection, Fecundity, and Age of First Pregnancy in Women," *Science* 350 (2015): 970–972.
31. A. Y. Panchin, A. I. Tuzhikov, and Y. V. Panchin, "Midichlorians—the Biomeme Hypothesis: Is There a Microbial Component to Religious Rituals?," *Biology Direct* 9 (2014): 14. See also S. K. Johnson et al., "Risky Business: Linking *Toxoplasma gondii* Infection and Entrepreneurship Behaviours Across Individuals and Countries," *Proceedings of the Royal Society B* 285 (2018): 20180822.
32. L. T. Morran et al., "Running with the Red Queen: Host-Parasite Coevolution Selects for Biparental Sex," *Science* 333 (2011): 216–218. This "running in place" phenomenon may explain the origins of sexual reproduction. See M. Ridley, *The Red Queen: Sex and the Evolution of Human Nature* (New York: Macmillan, 1993).
33. J. W. Bradbury and S. L. Vehrencamp, *Principles of Animal Communication*, 2nd ed. (Oxford: Oxford University Press, 2011).
34. N. Demandt, B. Saus, R. H. J. M. Kurvers, J. Krause, J. Kurtz, and J. P. Schar sack, "Parasite-Infected Sticklebacks Increase the Risk-Taking Behavior of Uninfected Group Members," *Proceedings of the Royal Society B* 285 (2018): 20180956.
35. Even this example could get complicated. If the manner of deposition of feces resulted in the ground becoming more fertile in a way that was beneficial to the organism, then, yes, this would be seen as an exophenotypic effect.
36. Dawkins, *Extended Phenotype*, pp. 206–207.
37. L. Glowacki, A. Isakov, R. W. Wrangham, R. McDermott, J. H. Fowler, and N. A. Christakis, "Formation of Raiding Parties for Intergroup Violence Is Mediated by Social Network Structure," *PNAS: Proceedings of the National Academy of Sciences* 113 (2016): 12114–12119.
38. F. Biscarini, H. Bovenhuis, J. van der Poel, T. B. Rodenburg, A. P. Jungerius, and J. A. M. van Arendonk, "Across-Line SNP Association Study for Direct and Associative Effect on Feather Damage in Laying Hens," *Behavior Genetics* 40 (2010): 715–727.
39. Dawkins, *Extended Phenotype*, p. 230.
40. P. Lieberman, "The Evolution of Human Speech," *Current Anthropology* 48 (2007): 39–66; D. Ploog, "The Neural Basis of Vocalization," in T. J. Crow, ed., *The Speciation of Modern Homo Sapiens* (Oxford: Oxford University Press, 2002), pp. 121–135; W. Enard et al., "Molecular Evolution of *FOXP2*, a Gene Involved in Speech and Language," *Nature* 418 (2002): 869–872; F. Vargha-Khadem, D. G. Gadian, A. Copp, and M. Mishkin,

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- "*FOXP2* and the Neuroanatomy of Speech and Language," *Nature Reviews Neuroscience* 6 (2005): 131–138; E. G. Atkinson, "No Evidence for Recent Selection at *FOXP2* Among Diverse Human Populations," *Cell* 174 (2018): 1424–1435 (which casts doubt on a crucial role of *FOXP2* in human speech).
41. J. H. Fowler, C. T. Dawes, and N. A. Christakis, "Model of Genetic Variation in Human Social Networks," *PNAS: Proceedings of the National Academy of Sciences* 106 (2009): 1720–1724.
 42. L. N. Trut, "Early Canid Domestication: The Farm-Fox Experiment," *American Scientist* 87 (1999): 160–169.
 43. *Ibid.*, p. 163.
 44. E. Ratliff, "Taming the Wild," *National Geographic*, March 2011.
 45. B. Hare, V. Wobber, and R. Wrangham, "The Self-Domestication Hypothesis: Evolution of Bonobo Psychology Is Due to Selection Against Aggression," *Animal Behaviour* 83 (2012): 573–585.
 46. K. Prufer et al., "The Bonobo Genome Compared with the Chimpanzee and Human Genomes," *Nature* 486 (2012): 527–531.
 47. B. Hare and S. Kwetuenda, "Bonobos Voluntarily Share Their Own Food with Others," *Current Biology* 20 (2010): 230–231.
 48. Hare, Wobber, and Wrangham, "Self-Domestication Hypothesis."
 49. C. Theofanopoulou et al., "Self-Domestication in *Homo sapiens*: Insights from Comparative Genomics," *PLOS ONE* 12 (2017): e0185306.
 50. S. Pinker, *Better Angels of Our Nature: Why Violence Has Declined* (New York: Viking, 2011).
 51. "Intentional Homicides (per 100,000 People)," World Bank, https://data.worldbank.org/indicator/VC.IHR.PSRC.P5?year_high_desc=false.

Chapter 11: Genes and Culture

1. A. D. Carlson, "The Wheat Farmer's Dilemma: Notes from Tractor Land," *Harper's*, July 1931, pp. 209–210. Some punctuation changed for clarity. See also R. C. Williams, *Fordson, Farmall, and Poppin' Johnny: A History of the Farm Tractor and Its Impact on America* (Champaign: University of Illinois Press, 1987).
2. Agricultural historian Bruce Gardner estimates that a tractor did the work of five horses and that the number of horses and mules peaked in about 1920 (at perhaps twenty-five million animals) whereas the number of tractors peaked around 1960 (at perhaps five million), with a crossover point in about 1945 when the two sources provided roughly equal power for farms. B. L. Gardner, *American Agriculture in the Twentieth Century: How It Flourished and What It Cost* (Cambridge, MA: Harvard University Press, 2006).
3. "Mechanization on the Farm in the Early Twentieth Century," excerpt from *The People in the Pictures: Stories from the Wettach Farm Photos* (Iowa Public Television, 2003), Iowa Pathways, <http://www.iptv.org/iowapathways/artifact/mechanization-farm-early-20th-century>.
4. Some potentially disadvantageous implications also affected everyone. For instance, tractors made farmers more independent, so social customs regarding the exchange of labor died out, and neighbors no longer needed to rely on one another as much.

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5. D. Thompson, "How America Spends Money: 100 Years in the Life of the Family Budget," *Atlantic*, April 5, 2012. See also: US Department of Agriculture Economic Research Service, "Food Expenditures," data available at <https://www.ers.usda.gov/data-products/food-expenditures/>. In 1900, 41 percent of the workforce was employed in agriculture; in 2000, only 1.9 percent was. See C. Dimitri, A. Effland, and N. Conklin, "The 20th Century Transformation of U.S. Agriculture and Farm Policy," United States Department of Agriculture, *Economic Information Bulletin* 3 (2005).
6. Where you were born also mattered, as technological innovation proceeded at different speeds on different continents.
7. D. Tuzin, *The Cassowary's Revenge: The Life and Death of Masculinity in a New Guinea Society* (Chicago: University of Chicago Press, 1997), p. 102.
8. One estimate offered that "to till an acre of land with a spade required 96 hours (5,760 minutes); to plow an acre with a yoke of oxen and a crude wooden plow took twenty-four hours (1,440 minutes); with a steel plow such as John Deere developed took five to eight hours (300 to 480 minutes); but in 1998, a 425-horsepower John Deere 9400 four-wheel-drive pulling a fifteen-bottom plow tilled an acre every 3.2 minutes.... Everyone who enjoys the abundant supply of inexpensive food should be grateful for John Deere and his plow." H. M. Drache, "The Impact of John Deere's Plow," *Illinois History Teacher* 8, no. 1 (2001): 2–13, <http://www.lib.niu.edu/2001/iht810102.html>. For one exploration of the growth of knowledge, see C. Hidalgo, *Why Information Grows: The Evolution of Order, from Atoms to Economies* (New York: Basic Books, 2015).
9. M. Fackler, "Tsunami Warnings, Written in Stone," *New York Times*, April 20, 2011. There is also the related phenomenon of designating the low-water marks in European rivers. The Elbe River in the Czech Republic is dotted with "hunger stones" commemorating historic droughts, with inscriptions like IFYOU SEE ME, WEEP, going back five hundred years. See C. Domonoske, "Drought in Central Europe Reveals Cautionary 'Hunger Stones' in Czech Republic," NPR, August 24, 2018.
10. S. Bhuaamik, "Tsunami Folklore 'Saved Islanders,'" BBC News, January 20, 2005.
11. There are some exceptions, such as the invention of brush heads on insect fishing rods used by chimps and the birdsongs that are specific to locations and that can get ever more complex with passing generations. J. Henrich and C. Tennie, "Cultural Evolution in Chimpanzees and Humans," in M. Muller, R. Wrangham, and D. Pilbeam, eds., *Chimpanzees and Human Evolution* (Cambridge, MA: Harvard University Press, 2017), pp. 645–702.
12. P. J. Richerson and R. Boyd, *Not by Genes Alone: How Culture Transformed Human Evolution* (Chicago: University of Chicago Press, 2005), p. 5.
13. J. Henrich, *The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter* (Princeton, NJ: Princeton University Press, 2016). See also K. N. Laland, J. Odling-Smee, and S. Myles, "How Culture Shaped the Human Genome: Bringing Genetics and the Human Sciences Together," *Nature Reviews Genetics* 11 (2010): 137–148; and P. J. Richerson, R. Boyd, and J. Henrich, "Gene-Culture Coevolution in the Age of Genomics," *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 8985–8992.

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14. J. Henrich and J. Broesch, "On the Nature of Cultural Transmission Networks: Evidence from Fijian Village for Adaptive Learning Biases," *Philosophical Transactions of the Royal Society B* 366 (2011): 1139–1148; M. Chudek, S. Heller, S. Birch, and J. Henrich, "Prestige-Biased Cultural Learning: Bystanders' Differential Attention to Potential Models Influences Children's Learning," *Evolution and Human Behavior* 38 (2012): 46–56.
15. M. Nielsen and K. Tomaselli, "Overimitation in Kalahari Bushman Children and the Origins of Human Cultural Cognition," *Psychological Science* 21 (2010): 729–736.
16. B. G. Galef, "Strategies for Social Learning: Testing Predictions from Formal Theory," *Advances in the Study of Behavior* 39 (2009): 117–151; W. Hoppitt and K. N. Laland, "Social Processes Influencing Learning in Animals: A Review of the Evidence," *Advances in the Study of Behavior* 38 (2008): 105–165.
17. J. Henrich and F. J. Gil-White, "The Evolution of Prestige: Freely Conferred Deference as a Mechanism for Enhancing the Benefits of Cultural Transmission," *Evolution and Human Behavior* 22 (2001): 165–196.
18. I. G. Kulanci, A. A. Ghazanfar, and D. I. Rubenstein, "Knowledgeable Lemurs Become More Central in Social Networks," *Current Biology* 28 (2018): 1306–1310.
19. M. Chudek et al., "Prestige-Biased Cultural Learning"; P. L. Harris and K. H. Corriveau, "Young Children's Selective Trust in Informants," *Philosophical Transactions of the Royal Society B* 366 (2011): 1179–1187.
20. Henrich and Broesch, "Nature of Cultural Transmission Networks."
21. The possible role of genes and heritability in social hierarchy is still being worked out. See M. A. Vanderkooij and C. Sandi, "The Genetics of Social Hierarchies," *Current Opinions in Behavioral Sciences* 2 (2015): 52–57. Regardless of whether dominance (in males) arises from genetic or other sources, this attribute does not seem to be transmitted across many generations in the male line, however. See J. S. Lansing et al., "Male Dominance Rank Skews the Frequency Distribution of Y Chromosome Haplotypes in Human Populations," *PNAS: Proceedings of the National Academy of Sciences* 105 (2008): 11645–11650.
22. J. L. Martin, "Is Power Sexy?," *American Journal of Sociology* 111 (2005): 408–446.
23. J. Snyder, L. Kirkpatrick, and C. Barrett, "The Dominance Dilemma: Do Women Really Prefer Dominant Men as Mates?," *Personal Relations* 15 (2008): 425–444.
24. C. von Ruden, M. Gurven, and H. Kaplan, "Why Do Men Seek? Fitness Payoffs to Dominance and Prestige," *Proceedings of the Royal Society B* 278 (2011): 2223–2232. Much of what counted as prestige here was simply the number of friends the men had. Dominance status peaks about a decade before prestige status in the Tsimané (and likely in other populations). See C. C. von Ruden, M. Gurven, and H. Kaplan, "The Multiple Dimensions of Male Social Status in an Amazonian Society," *Evolution and Human Behavior* 29 (2008): 402–415.
25. This expression was coined by Robert Boyd. Henrich, *Secret of Our Success*, p. 26.
26. *Ibid.*, p. 27.
27. R. E. Schultes, "Ethnopharmacological Conservation: A Key to Progress in Medicine," *Acta Amazonica* 18 (1988): 393–406.
28. Some Amazonian tribes have even developed ways of assessing the strength of their poisons by counting the number of times a captive test frog can jump after being pricked.

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- Another metric involves counting how many trees a monkey can leap to after being struck with a dart. A one-tree concentration is very potent and deadly, but the weaker three-tree curare is used to subdue live animals to keep as pets. In general, blowgun darts kill small animals quickly, but it might take twenty minutes and many darts for large monkeys or tapirs to die. Ethnobotanist Steve Beyer was told by a member of the formerly headhunting Shapra who live on the border between Peru and Ecuador that it can take up to twenty darts to bring down a human. S. Beyer, "Arrow Poisons," *Singing to the Plants: Steve Beyer's Blog on Ayahuasca and the Amazon*, <http://www.singingtotheplants.com/2008/01/arrow-poisons/>; S. V. Beyer, *Singing to the Plants: A Guide to Mestizo Shamanism in the Upper Amazon* (Albuquerque: University of New Mexico Press, 2009).
29. Preparation procedures in other tribes can be simpler and faster. L. Rival, "Blowpipes and Spears: The Social Significance of Huaorani Technological Choices," in P. Descola and G. Palsson, eds., *Nature and Society: Anthropological Perspectives* (London: Routledge, 1996), pp. 145–164.
 30. C. R. Darwin, *The Descent of Man, and Selection in Relation to Sex* (London: John Murray, 1871). This idea traces through important work by geneticists Marcus Feldman and Luigi Luca Cavalli-Sforza in the 1970s, to work by Robert Boyd and Peter Richerson in the 1980s, through ongoing work by Joe Henrich, Ken Laland, and others more recently. See M. Feldman and L. Cavalli-Sforza, "Cultural and Biological Evolutionary Processes, Selection for a Trait Under Complex Transmission," *Theoretical Population Biology* 9 (1976): 238–259.
 31. M. T. Pfeffer, "Implications of New Studies of Hawaiian Fishhook Variability for Our Understanding of Polynesian Settlement History," in G. Rakita and T. Hurt, eds., *Style and Function: Conceptual Issues in Evolutionary Archaeology* (Westport, CT: Bergin and Garvey, 2001), pp. 165–181.
 32. The spread and simultaneity of fishhook invention is a challenging topic because we do not yet know the complete story. And, of course, natural selection, unlike an inventor, does not have a purpose in advance. F. Jacob, "Evolution and Tinkering," *Science* 196 (1977): 1161–1166. See also P. V. Kirch, *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory* (Honolulu: University of Hawaii Press, 1997).
 33. R. C. Dunnell, "Style and Function: A Fundamental Dichotomy," *American Antiquity* 43 (1978): 192–202.
 34. Scientists have long taken note of the possible existence of common traits (e.g., biological, technological, cultural) across disparate exemplars (e.g., organisms, machines, societies). Beginning in the nineteenth century, anatomists (such as Richard Owen) started conceptually distinguishing between different classes of biological structures with shared functions and forms, designating these structures as either "homologous" or "analogous." Whereas homologous structures arise from a common evolutionary origin and transmission, analogous structures evolve independently as a common solution to a similar set of environmental challenges. Analogous traits, therefore, emerge through the process of convergent evolution. It is, of course, possible that homologues with common cultural lineages are functional. Many different processes—from convergence to diffusion—can ultimately perpetuate both functional and stylistic traits.

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35. F. M. Reinman, "Fishing: An Aspect of Oceanic Economy; An Archaeological Approach," *Fieldiana: Anthropology* 56 (1967): 95–208.
36. S. O'Connor, R. Ono, and C. Clarkson, "Pelagic Fishing at 42,000 Years Before the Present and the Maritime Skills of Modern Humans," *Science* 334 (2011): 1117–1121.
37. B. Gramsch, J. Beran, S. Hanik, and R. S. Sommer, "A Palaeolithic Fishhook Made of Ivory and the Earliest Fishhook Tradition in Europe," *Journal of Archaeological Science* 40 (2013): 2458–2463.
38. D. Sahrhage and J. Lundbeck, *A History of Fishing* (Berlin: Springer-Verlag, 1992). These hooks appear to have incorporated a harpoon-type barb approximately eleven thousand years ago, and it seems that thereafter, examples of typical barbed, line-attached hooks spread from northern Eurasia, first to northeastern (but not western) Europe and China and later to Japan, Polynesia, and the northwestern American coast. By the Bronze Age, roughly forty-three hundred years ago, fishhooks made of metal, as well as more traditional materials (such as bone and flint), were virtually ubiquitous in coastal populations.
39. R. F. Heizer, "Artifact Transport by Migratory Animals and Other Means," *American Antiquity* 9 (1944): 395–400. See also L. C. W. Landberg, "Tuna Tagging and the Extra-Oceanic Distribution of Curved, Single-Piece Shell Fishhooks in the Pacific," *American Antiquity* 31 (1966): 485–493; and F. M. Reinman, "Tuna Tagging and Shell Fishhooks: A Comment from Oceania," *American Antiquity* 33 (1968): 95–100.
40. Reinman, "Tuna Tagging"; F. M. Reinman, "Fishhook Variability: Implications for the History and Distribution of Fishing Gear in Oceania," in R. C. Green and M. Kelly, eds., *Studies in Oceanic Culture History*, vol. 1 (Honolulu: Bernice Pauahi Bishop Museum, 1970) pp. 47–59; P. V. Kirch, "The Archaeological Study of Adaptation: Theoretical and Methodological Issues," *Advances in Archaeological Method and Theory* 3 (1980): 101–156.
41. Knowledge can be lost entirely. A complex astronomical device with toothed gears known as the Antikythera mechanism (which was found underwater in Greece in 1902) was not re-created for over one thousand years. T. Freeth et al., "Decoding the Ancient Greek Astronomical Calculator Known as the Antikythera Mechanism," *Nature* 444 (2006): 587–591. In another example, as of 2017, there was one last surviving sea-silk seamstress, in Italy; when she dies, the secrets of the craft, which have been in the same matrilineal clan for more than a thousand years, will be lost. E. Stein, "The Last Surviving Sea Silk Seamstress," BBC, September 6, 2017, <http://www.bbc.com/travel/story/20170906-the-last-surviving-sea-silk-seamstress>. Incidentally, this observation means that cognitively identical populations, such as ancestral hominin species, may leave different archaeological evidence not because of their brains but because of their population size. Henrich, *Secret of Our Success*, chapter 13.
42. N. Casey, "Thousands Spoke His Language in the Amazon. Now, He's the Only One," *New York Times*, December 26, 2017.
43. L. Bromham, X. Hua, T. G. Fitzpatrick, and S. J. Greenhill, "Rate of Language Evolution Is Affected by Population Size," *PNAS: Proceedings of the National Academy of Sciences* 112 (2015): 2097–2102.

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44. M. A. Kline and R. Boyd, "Population Size Predicts Technological Complexity in Oceania," *Proceedings of the Royal Society B* 277 (2010): 2559–2564. But see the following two papers, which examined populations drawn from the northwestern coastal regions of North America, for conflicting evidence regarding the relationship of population size and tool-kit size: M. Collard, M. Kemery, and S. Banks, "Causes of Tool Kit Variation Among Hunter-Gatherers: A Test of Four Competing Hypotheses," *Canadian Journal of Archeology* 29 (2005): 1–19; D. Read, "An Interaction Model for Resource Implement Complexity Based on Risk and Number of Annual Moves," *American Antiquity* 73 (2008): 599–625.
45. W. Oswalt, *An Anthropological Analysis of Food-Getting Technology* (New York: John Wiley and Sons, 1976); R. Torrence, "Hunter-Gatherer Technology: Macro and Microscale Approaches," in C. Panter-Brick, R. H. Layton, and P. Rowley-Conwy, eds., *Hunter-Gatherers: An Interdisciplinary Perspective* (Cambridge: Cambridge University Press, 2000), pp. 99–143.
46. Collard, Kemery, and Banks, "Causes of Tool Kit Variation."
47. M. Derex, M.-P. Beugin, B. Godelle, and M. Raymond, "Experimental Evidence for the Influence of Group Size on Cultural Complexity," *Nature* 503 (2013): 389–391.
48. For an early and simplified model of this, see J. Henrich, "The Evolution of Innovation-Enhancing Institutions," in M. J. O'Brien and S. J. Shennan, eds., *Innovation in Cultural Systems: Contributions from Evolutionary Anthropology* (Cambridge, MA: MIT Press, 2010), pp. 99–120.
49. There was likely culture before our species, *Homo sapiens*. Humans have surely had some aspect of it as long as we have been engaged in complex foraging, which dates back at least to *Homo erectus* (who lived from about 1.9 million years ago to about one hundred and forty-three thousand years ago). Hence, culture probably began to shape our genes even earlier than one million years ago.
50. Moreover, by about four hundred thousand years ago, we find regional variation in stone tools in the archaeological record, which is consistent with variation from place to place in local culture.
51. At the other extreme, if the environment is sufficiently stable, individual learning may be sufficient, and social learning may offer little, if any, gain in efficiency or sophistication, so why bother with evolving this capacity?
52. R. Wrangham, *Catching Fire: How Cooking Made Us Human* (New York: Basic Books, 2009).
53. On running barefoot, see D. E. Lieberman et al., "Foot Strike Patterns and Collision Forces in Habitually Barefoot Versus Shod Runners," *Nature* 463 (2010): 531–535.
54. D. E. Lieberman, *The Story of the Human Body: Evolution, Health, and Disease* (New York: Pantheon, 2013).
55. M. W. Feldman and L. L. Cavalli-Sforza, "On the Theory of Evolution Under Genetic and Cultural Transmission, with Application to the Lactose Absorption Problem," in M. W. Feldman, ed., *Mathematical Evolutionary Theory* (Princeton, NJ: Princeton University Press, 1989), pp. 145–173; K. Aoki, "A Stochastic Model of Gene-Culture Coevolution Suggested by the 'Culture Historical Hypothesis' for the Evolution of

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- Adult Lactose Absorption in Humans,” *PNAS: Proceedings of the National Academy of Sciences* 83 (1986): 2929–2933.
56. Y. Itan, B. L. Jones, C. J. E. Ingram, D. M. Swallow, and M. G. Thomas, “A Worldwide Correlation of Lactase Persistence Phenotype and Genotype,” *BMC Evolutionary Biology* 10 (2019): 36.
57. S. A. Tishkoff et al., “Convergent Adaptation of Human Lactase Persistence in Africa and Europe,” *Nature Genetics* 39 (2007): 31–40. Other studies have documented that the relevant gene variants were not present in ancestral humans. J. Burger, M. Kirchner, B. Bramanti, W. Haak, and M. G. Thomas, “Absence of Lactase-Persistence-Associated Alleles in Early Neolithic Europeans,” *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 3736–3741. Regarding the likely independent evolution of lactase persistence in response to camel domestication, see N. S. Enattah et al., “Independent Introduction of Two Lactase-Persistence Alleles into Human Populations Reflects Different History of Adaptation to Milk Culture,” *American Journal of Human Genetics* 82 (2008): 57–72.
58. C. Sather, *The Bajau Laut: Adaptations, History, and Fate in a Maritime Fishing Society of South-Eastern Sabah* (Oxford: Oxford University Press, 1997).
59. E. Schagatay, A. Lodin-Sundstrom, and E. Abrahamsson, “Underwater Working Times in Two Groups of Traditional Apnea Divers in Asia: The Ama and the Bajau,” *Diving and Hyperbaric Medicine* 41 (2011): 27–30.
60. M. A. Ilardo et al., “Physiological and Genetic Adaptations to Diving in Sea Nomads,” *Cell* 173 (2018): 569–580.
61. S. Myles et al., “Identification of a Candidate Genetic Variant for the High Prevalence of Type Two Diabetes in Polynesians,” *European Journal of Human Genetics* 15 (2007): 584–589; J. R. Binden and P. T. Baker, “Bergmann’s Rule and the Thrifty Genotype,” *American Journal of Physical Anthropology* 104 (1997): 201–210; P. Houghton, “The Adaptive Significance of Polynesian Body Form,” *Annals of Human Biology* 17 (1990): 19–32. See also R. L. Minster et al., “A Thrifty Variant in *CREBRF* Strongly Influences Body Mass Index in Samoans,” *Nature Genetics* 48 (2016): 1049–1054.
62. D. Dediu and D. R. Ladd, “Linguistic Tone Is Related to the Population Frequency of the Adaptive Haplogroups of Two Brain Size Genes, *ASP* and *Microcephalin*,” *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 10944–10949.
63. O. Galor and Ö. Özak, “The Agricultural Origins of Time Preference,” *American Economic Review* 106 (2016): 3064–3103.
64. In the case of starchy foods and amylase, the specific genetic mechanism here may be different, involving something known as copy-number variation. G. H. Perry, “Diet and the Evolution of Human Amylase Gene Copy Number Variation,” *Nature Genetics* 39 (2007): 1256–1260.
65. W. H. Durham, *Coevolution: Genes, Culture, and Human Diversity* (Stanford, CA: Stanford University Press, 1991), pp. 103–109. See also M. J. O’Brien and K. N. Laland, “Genes, Culture, and Agriculture: An Example of Human Niche Construction,” *Current Anthropology* 53 (2012): 434–470.

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66. Alas, these same mutations also increase the risk of cystic fibrosis. E. van de Vosse et al., "Susceptibility to Typhoid Fever Is Associated with a Polymorphism in the Cystic Fibrosis Transmembrane Conductance Regulator (CFTR)," *Human Genetics* 118 (2005): 138–140; E. M. Poolman and A. P. Galvani, "Evaluating Candidate Agents of Selective Pressure for Cystic Fibrosis," *Journal of the Royal Society Interface* 4 (2007): 91–98. See also J. Hawks, E. T. Wang, G. M. Cochran, H. C. Harpending, and R. K. Moyzis, "Recent Acceleration of Human Adaptive Evolution," *PNAS: Proceedings of the National Academy of Sciences* 104 (2007): 20753–20758; and W. McNeill, *Plagues and Peoples* (Garden City, NY: Doubleday, 1976).
67. C. L. Apicella, "High Levels of Rule-Bending in a Minimally Religious and Largely Egalitarian Forager Population," *Religion, Brain and Behavior* 8 (2018): 133–148. See also A. Norenzayan et al., "The Cultural Evolution of Prosocial Religions," *Behavioral and Brain Sciences* 39 (2016): 1–65.
68. C. Apicella, personal communication, November 1, 2017.
69. For a review, see P. B. Gray and B. C. Campbell, "Human Male Testosterone, Pair-Bonding, and Fatherhood," in P. T. Ellison and P. B. Gray, eds., *Endocrinology of Social Relationships* (Cambridge, MA: Harvard University Press, 2009), pp. 270–293. See also P. B. Gray, S. M. Kahlenberg, E. S. Barrett, S. F. Lipson, and P. T. Ellison, "Marriage and Fatherhood Are Associated with Lower Testosterone in Males," *Evolution and Human Behavior* 23 (2002): 193–201; A. E. Storey, C. J. Walsh, R. L. Quinton, and K. E. Wynne-Edwards, "Hormonal Correlates of Paternal Responsiveness in New and Expectant Fathers," *Evolution and Human Behavior* 21 (2000): 79–95; and S. M. van Anders and N. V. Watson, "Relationship Status and Testosterone in North American Heterosexual and Non-Heterosexual Men and Women: Cross-Sectional and Longitudinal Data," *Psychoneuroendocrinology* 31 (2006): 715–723. Entry into marriage and fatherhood may not reduce testosterone in polygynous societies, however, and the reason is likely that married men are still seeking reproductive partners. P. B. Gray, "Marriage, Parenting, and Testosterone Variation Among Kenyan Swahili Men," *American Journal of Physical Anthropology* 122 (2003): 279–286. Regarding the necessity of face-to-face interaction with one's children, see M. N. Muller, F. W. Marlowe, R. Bugumba, and P. T. Ellison, "Testosterone and Paternal Care in East African Foragers and Pastoralists," *Proceedings of the Royal Society B* 276 (2009): 347–354.
70. J. F. Schulz, "The Churches' Ban on Consanguineous Marriages, Kin-Networks, and Democracy" (paper, June 12, 2017), <https://ssrn.com/abstract=2877828>.
71. A. H. Bittles and M. L. Black, "Consanguinity, Human Evolution, and Complex Diseases," *PNAS: Proceedings of the National Academy of Sciences* 107 (2010): 1779–1786. Mortality among first-cousin progeny is about 3.5 percent higher than it is among nonconsanguineous offspring. While there are therefore such inbreeding costs, those costs might be compensated by the *social* benefits of tight families, at least in some environments. The impact of consanguineous marriage may also vary between modern environments and older or more traditional environments. And women in societies with cousin marriage have much higher fertility (that is, more babies), which might compensate for their increased infant mortality. The tight family bonds in

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- consanguineous marriages might also supply lots of alloparents to help the mother. Hence, overall, the selection pressure might actually go the other way, in favor of such consanguineous marriages, in some circumstances.
72. R. Boyd and P. J. Richerson, "Cultural Transmission and the Evolution of Cooperative Behavior," *Human Ecology* 10 (1982): 325–351; R. Boyd and P. J. Richerson, "The Evolution of Reciprocity in Sizeable Groups," *Journal of Theoretical Biology* 132 (1988): 337–356; M. Chudek and J. Henrich, "Culture-Gene Coevolution, Norm-Psychology and the Emergence of Human Prosociality," *Trends in Cognitive Sciences* 15 (2011): 218–226; R. Boyd, H. Gintis, S. Bowles, and P. J. Richerson, "The Evolution of Altruistic Punishment," *PNAS: Proceedings of the National Academy of Sciences* 100 (2003): 3531–3535; J. Henrich et al., "Costly Punishment Across Human Societies," *Science* 312 (2006): 1767–1770; H. Gintis, "The Hitchhiker's Guide to Altruism: Gene Culture Coevolution and the Internalization of Norms," *Journal of Theoretical Biology* 220 (2003): 407–418; H. Gintis, "The Genetic Side of Gene-Culture Coevolution: Internalization of Norms and Prosocial Emotions," *Journal of Economic Behavior and Organization* 53 (2004): 57–67. The same types of mathematical analyses can help explain the emergence of prosocial emotions (that warm glow you feel in the company of your friends).
 73. Laland, Odling-Smee, and Myles, "How Culture Shaped the Human Genome"; Hawks, et al., "Recent Acceleration of Human Adaptive Evolution." Of course, any acceleration in human evolution may be due to factors other than the emergence of cultural selection pressures. Another issue, for example, is the rise in the number of humans on the planet. With larger populations of an animal, beneficial mutations are more likely to occur somewhere in the population simply by chance; these larger populations of our species may have been facilitated by the invention of agriculture. However, it is also the case that cultural impacts can cease or reverse, which would mean that the genetic changes would be incomplete (a "partial genetic sweep" that did not reach "fixation" in the population).
 74. X. Yi et al., "Sequencing of Fifty Human Exomes Reveals Adaptation to High Altitude," *Science* 329 (2010): 75–78.
 75. I imagine, however, that the settlers could have created cultural or religious rules that "required" them to make periodic trips or pilgrimages to the lowlands (which might have helped to reduce the stress of being at high altitudes the rest of the time). In modern times, I suppose they could import bottled oxygen.
 76. Some scientists have speculated that as cultural adaptation supplanted genetic adaptation, the pace of human genetic evolution should have *slowed*. But this seems unlikely not only because of evidence of a quickening pace to evolution in the past forty thousand years, but also because the migration into new environments and the creation of new cultural niches could themselves serve to increase the selective pressures on new allelic variants in human populations (e.g., to cope with new infections made likely by dense settlements or to cope with new foodstuffs).
 77. To be clear, the recent increase in myopia is not primarily due to the weakening of selection pressure but rather arises because of changes in lifestyle that bring people indoors and affect what distance they are focusing on while their eyes are developing in childhood. Focusing on items far away, in bright light, as when people spend more time

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- outside and less time indoors, may be necessary to avoid myopia. East Asia, in particular, is seeing an epidemic of myopia. Sixty years ago, about 10 to 20 percent of the Chinese population was nearsighted; now up to 90 percent of teenagers and young adults are. For a good review, see E. Dolgin, “The Myopia Boom,” *Nature* 519 (2015): 276–278.
78. O. S. Platt et al., “Mortality in Sickle Cell Disease—Life Expectancy and Risk Factors for Early Death,” *New England Journal of Medicine* 330 (1994): 1639–1644.
 79. Plus, for female patients with sickle-cell disease, pregnancy used to be so dangerous to the mother and fetus that doctors would recommend birth control if patients made it to sexual maturity, hence obviating reproduction.
 80. D. G. Finniss, T. J. Kaptchuk, F. Miller, and F. Benedetti, “Biological, Clinical, and Ethical Advances of Placebo Effects,” *Lancet* 375 (2010): 686–695.
 81. There is some evidence that, in a modern British population, intelligence and educational achievement are being selected *against* (i.e., such populations have lower fecundity). J. S. Sanjak, J. Sidorenko, M. R. Robinson, K. R. Thornton, and P. M. Visscher, “Evidence of Directional and Stabilizing Selection in Contemporary Humans,” *PNAS: Proceedings of the National Academy of Sciences* 115 (2017): 151–156.
 82. J. Tooby and L. Cosmides, “Evolutionary Psychology and the Generation of Culture. I: Theoretical Considerations,” *Ethology and Sociobiology* 10 (1989): 29–49; J. H. Barkow, L. Cosmides, and J. Tooby, eds., *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Oxford: Oxford University Press, 1992).
 83. G. Cochran and H. Harpending, *The 10,000 Year Explosion: How Civilization Accelerated Human Evolution* (New York: Basic Books, 2009).

Chapter 12: Natural and Social Laws

1. Sometimes, the analogy is applied to explain the workings of the body, for example when the immune system is seen as an “army.” But usually, the metaphor of the body is used the other way around, to illuminate the function of society. See: E. Martin, *Flexible Bodies* (Boston: Beacon Press, 1995). Rudolf Virchow, one of the leading physicians of the nineteenth century, described the functioning of the human body in terms of a society, with each cell a citizen. He submitted that living organisms represented a kind of “cellular democracy,” a “republic of cells,” and a “cellular state.” R. Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity* (New York: W. W. Norton, 1999), p. 331. Conversely, Herbert Spencer, a nineteenth-century Englishman who dabbled in a wide array of disciplines, saw human society as a scaled-up analogue of the human body. H. Spencer, *The Principles of Biology* (London: Williams and Norgate, 1864).
2. T. L. Patavinus, *History of Rome*, trans. C. Roberts, bk. 2 (London: J. M. Dent and Sons, 1905).
3. One of Aesop’s fables, “The Belly and the Members,” closely parallels this speech by Menenius Agrippa. J. Jacobs, *The Fables of Aesop* (London: Macmillan, 1902), pp. 72–73. Indeed, fables of the body and the belly occur in an assortment of other texts, according to Jacobs, including a 1250 BCE Egyptian allegory located in the Upanishads; a Buddhist fable tucked within the Chinese Avadanas; and Jewish and Christian varieties scattered throughout the Bible.

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4. A. F. Jensen, *India: Its Culture and People* (New York: Longman, 1991), p. 32. This order of castes is typically as follows: the Brahman, or priestly, caste represents society's head; the Kshatriya, or warrior, caste is analogized to its arms; the Vaishya caste (traders and landowners) are the legs; and the Sudra caste (servants) are the feet.
5. Plato, *Republic*, bk. 4, 436b.
6. 1 Cor. 12:15–26 (English Standard Version).
7. See, for example, A. D. Harvey, *Body Politic: Political Metaphor and Political Violence* (Newcastle, UK: Cambridge Scholars, 2007). Writing in 1518, statesman Thomas More provided a typical characterization: "A kingdom in all its parts is like a man. . . . The king is the head; the people form the other parts." *Ibid.*, p. 23. See also C. W. Mills, "Body Politic, Bodies Impolitic," *Social Research* 78 (2011): 583–606.
8. T. Hobbes, *Leviathan* (Whitefish, MT: Kessinger, 2004), p. 1.
9. The Leviathan wears a crown and holds a sword in his right hand and a crook in his left—symbols, perhaps, of force and justice. These symbols also relate to Hobbes's vision of a commonwealth that is both civil (sword/king) and ecclesiastical (crook/bishop). The two sides of the frontispiece, below the giant Leviathan, follow this dichotomy. Each side element reflects corresponding powers: castle to church, crown to miter, canon to excommunication, weapons to logic, and battlefield to religious courts. Hobbes sees the Leviathan as having humanlike qualities, including being prone to use violence for self-preservation. L. Ostman, "The Frontispiece of Leviathan—Hobbes' Bible Use," *Akadeimia* 2 (2012): ea0112.
10. This is usually given as Job 41:33 in modern English translations. Hobbes was surely familiar with the biblical notion of a fearsome, seagoing leviathan, which is mentioned in Job. And, indeed, the people on the sovereign's body appear like scales.
11. Hobbes, *Leviathan*, p. 16.
12. Regarding animal rights, see P. Singer, *Animal Liberation: A New Ethics for Our Treatment of Animals* (New York: Random House, 1975); and M. Scully, *Dominion: The Power of Man, the Suffering of Animals, and the Call to Mercy* (New York: St. Martin's, 2002).
13. N. K. Sanders, *The Epic of Gilgamesh* (Assyrian International News Agency Books Online, n.d.), tablet 1, p. 4, <http://www.aina.org/books/eog/eog.pdf>. At the beginning of the epic, these two beings—one untamed, another civilized—are in opposition. They eventually come together to form a harmonious friendship, but only after Enkidu is domesticated.
14. R. N. Bellah, *Religion in Human Evolution* (Cambridge, MA: Harvard University Press, 2011).
15. God commands humans to "be fruitful and multiply and fill the earth and subdue it, and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on the earth." Genesis 1:28 (English Standard Version). Humankind's ranking above, and separation from, nature is further cemented when God commands Adam to name all the creatures of the earth. Throughout the Bible, the wilderness is often portrayed as the cradle of evil and danger, the crucible where Jesus was tested by the Devil. Philosopher John Passmore contends that the Bible does not prescribe a single unified principle concerning how humans ought to

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- behave in relation to nature. J. A. Passmore, *Man's Responsibility for Nature: Ecological Problems and Western Traditions* (London: Duckworth, 1974).
16. Aristotle, *Politics*, trans. C. Lord (Chicago: University of Chicago Press, 2013). To be clear, Aristotle saw human minds as apart from nature, but he believed that human bodies, including their desires, were as animalistic as any part of nature and needed to be mastered.
 17. L. White Jr., "The Historical Roots of Our Ecological Crisis," *Science* 155 (1967): 1203–1207.
 18. T. Aquinas, *Summa Contra Gentiles*, trans. V. J. Bourke, bk. 3 (Notre Dame, IN: Notre Dame Press, 1975). Beyond underscoring human ascendancy and clarifying the anthropocentric purpose of nature, Aquinas also considered and then dismissed the possibility that humans imbued with a soul and reason might have certain ethical obligations to other creatures. T. Aquinas, *Summa Theologica*, trans. Fathers of the English Dominica Province (Cincinnati: Benziger Brothers, 1974). The teachings of Saint Francis are often highlighted by those seeking to demonstrate that early Christianity did not necessarily create a schism between humans and the natural world. In stark opposition to Aquinas, Francis asserted that one's treatment of the natural world should be directly modeled on one's treatment of one's own kind. But in fact, Francis's views were so discordant with Catholic Church dogma that historian Lynn White Jr. concluded, "The prime miracle of Saint Francis is the fact that he did not end at the stake." L. White, "The Historical Roots of Our Ecological Crisis," *Science* 155 (1967): 1203–1207.
 19. In some sense, therefore, the seemingly secular Scientific Revolution fostered the idea that humans had a right and a duty to subdue nature in alignment with God's divine will. See J. Agassi, *The Very Idea of Modern Science: Francis Bacon and Robert Boyle* (New York: Springer Dordrecht Heidelberg, 2012). See also C. Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York: HarperCollins, 1980).
 20. R. Descartes, *Meditations on First Philosophy*, trans. A. Anderson and L. Anderson (Baltimore: Agora, 2012).
 21. I. Kant, *Groundwork of the Metaphysics of Morals*, ed. M. Gregor and J. Timmermann, rev. ed. (Cambridge: Cambridge University Press, 2012).
 22. R. W. Emerson, *Nature, Addresses, and Lectures*, ed. A. R. Ferguson (Cambridge, MA: Belknap Press, 1971), pp. 13–28.
 23. C. R. Darwin, *The Descent of Man, and Selection in Relation to Sex* (London: John Murray, 1871).
 24. However, to attribute this surging interest in the untamed and sublime natural world entirely to the Industrial Revolution would be a gross oversimplification; these ideas first came to fruition before the Industrial Revolution, and many transcendentalists thought well of the progress induced by steam and coal power.
 25. The social sciences—spanning sociology, economics, anthropology, political science, and psychology—are composed of a number of different disciplinary traditions with varied topical, methodological, and philosophical underpinnings. L. McDonald, *Early Origins of the Social Sciences* (Montreal: McGill-Queen's University

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- Press, 1993). The fields of psychology and, to a lesser extent, anthropology have always had a strong biological component.
26. J. Searle, *The Construction of Social Reality* (New York: Free Press, 1995).
 27. S. M. Lindberg, J. S. Hyde, and J. L. Petersen, "New Trends in Gender and Mathematics Performance: A Meta-Analysis," *Psychological Bulletin* 136 (2010): 1123–1135.
 28. S. A. Cartwright, "Diseases and Peculiarities of the Negro Race," *DeBow's Review, Southern and Western States*, vol. 9, (New Orleans: n.p., 1851).
 29. S. Arbesman, *The Half-Life of Facts: Why Everything We Know Has an Expiration Date* (New York: Current, 2012).
 30. A. Comte, *A General View of Positivism*, trans. J. H. Bridges (London: Trubner, 1865).
 31. E. Durkheim, *The Rules of Sociological Method*, trans. W. D. Halls (New York: Free Press, 1982). Durkheim argued that a set of specifically social facts existed that was not reducible to individual humans, that there was a kind of holistic social reality that transcended the thoughts and actions of individuals, and that this reality required a special scientific method to appreciate.
 32. Plato, *The Republic*, trans. T. Griffith (Cambridge: Cambridge University Press, 2000); T. Gould, *The Ancient Quarrel Between Poetry and Philosophy* (Princeton, NJ: Princeton University Press, 1990).
 33. B. F. Skinner, *About Behaviorism* (New York: Knopf, 1974).
 34. V. Reppert, *C. S. Lewis's Dangerous Idea: In Defense of the Argument from Reason* (Downers Grove, IL: InterVarsity Press, 2003).
 35. Regarding beauty, see R. O. Prum, *The Evolution of Beauty: How Darwin's Forgotten Theory of Mate Choice Shapes the Animal World—and Us* (New York: Doubleday, 2017).
 36. As eloquently encapsulated by physicist Werner Heisenberg: "The positivists have a simple solution: the world must be divided into that which we can say clearly and the rest, which we had better pass over in silence. But can anyone conceive of a more pointless philosophy, seeing that what we can say clearly amounts to next to nothing? If we omitted all that is unclear, we would probably be left with completely uninteresting and trivial tautologies." W. Heisenberg, *Physics and Beyond: Memories of a Life in Science* (London: George Allen and Unwin, 1971), p. 213. By emphasizing only observable scientific facts, positivism misses much of the larger picture, on "the great ocean of truth." Heisenberg also argued that positivists could actually undermine their own program and illustrated this with an example from the history of science in which claims of meteorites in the eighteenth century were "dismissed as rank superstition," whereas, of course, they do exist.
 37. D. Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (New York: Knopf, 1985); R. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago: University of Chicago Press, 1973). We should also be cognizant of the "replication crisis" afflicting so many branches of science in the 2010s, including psychology, economics, physics, biology, epidemiology, and oncology.
 38. P. W. Anderson, "More Is Different," *Science* 177 (1972): 393–396.
 39. Interestingly, humans are natural-born essentialists. From an early age, we categorize objects according to fundamental commonalities, discriminate between these categories, and assign each category a basic essence. P. Bloom, *How Pleasure Works: The*

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- New Science of Why We Like What We Like* (New York: W. W. Norton, 2010); S. A. Gelman, *The Essential Child: Origins of Essentialism in Everyday Thought* (New York: Oxford University Press, 2010).
40. In the end, we would get Laplace's Demon. For "such an intellect," French mathematician Pierre-Simon Laplace argued in 1814, "nothing would be uncertain and the future just like the past would be present before its eyes." P. S. Laplace, *A Philosophical Essay on Probabilities*, 6th ed., trans. F. W. Truscott and F. L. Emory (New York: Dover, 1951), p. 4.
 41. There is actually much debate about whether the idea that the world obeys natural laws and is predictable can be reconciled with the idea that humans can truly have free will. Since both ideas—determinism and free will—seem so sensible and have so much philosophical and empirical support, people who hold the view that the two are compatible actually have a special name: *compatibilists*. The reason this is important is that determinism subverts the entire basis for moral assessment. How can we hold someone responsible for his or her choices and actions if they are determined by past events outside his or her control or, indeed, by the choices and actions of others?
 42. R. Lewontin, *Biology as Ideology: The Doctrine of DNA* (Concord, ON: House of Anansi Press, 1991); S. J. Gould, *The Mismeasure of Man* (New York: W. W. Norton, 1981).
 43. D. Nelkin, "Biology Is Not Destiny," *New York Times*, September 28, 1995. For two examples of such studies, see G. Guo, M. E. Roettger, and T. Cai, "The Integration of Genetic Propensities into Social-Control Models of Delinquency and Violence Among Male Youths," *American Sociological Review* 73 (2008): 543–568; and A. Feder, E. J. Nestler, and D. S. Charney, "Psychobiology and Molecular Genetics of Resilience," *Nature Reviews Neuroscience* 10 (2009): 446–457.
 44. J. Hibbing, "Ten Misconceptions Concerning Neurobiology and Politics," *Perspectives on Politics* 11 (2013): 475–489.
 45. For an early history, see M. H. Haller, *Eugenics: Hereditarian Attitudes in American Thought* (New Brunswick, NJ: Rutgers University Press, 1963).
 46. Such extreme adherence to the doctrine of a blank slate is very common in sociology. See M. Horowitz, A. Haynor, and K. Kickham, "Sociology's Sacred Victims and the Politics of Knowledge: Moral Foundations Theory and Disciplinary Controversies," *American Sociologist* (2018). For crime statistics, see E. A. Carson and D. Golinelli, "Prisoners in 2012—Advance Counts" (report no. NCJ 242467, Bureau of Justice Statistics, July 2013). Regarding the overwhelmingly male violence in chimpanzees in similar proportions as humans (in terms of both perpetrators and victims), see M. L. Wilson et al., "Lethal Aggression in *Pan* Is Better Explained by Adaptive Strategies Than Human Impact," *Nature* 513 (2014): 414–417; and J. M. Gomez, M. Verdo, A. Gonzalez-Negras, and M. Mendez, "The Phylogenetic Roots of Human Lethal Violence," *Nature* 538 (2016): 233–237.
 47. Some argue that even if knowledge of scientific reality led inexorably to eugenics and racial discrimination, it would not justify ignorance of that reality, because the supreme value is recognizing the truth, whatever it may be and whatever the costs of that knowledge.

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48. E. Fromm, *Man for Himself: An Inquiry into the Psychology of Ethics* (New York: Rinehart, 1947), p. 20.
49. *Ibid.*, pp. 20–21.
50. B. D. Earp, A. Sandeberg, and J. Savulescu, “Brave New Love: The Threat of High-Tech ‘Conversion’ Therapy and the Bio-Oppression of Sexual Minorities,” *AJOB Neuroscience* 5 (2014): 4–12.
51. Historicus, “Stalin on Revolution,” *Foreign Affairs*, January 1949, p. 196.
52. R. C. Tucker, “Stalin and the Uses of Psychology,” *World Politics* 8 (1956): 455–483. See also E. van Ree, *The Political Thought of Joseph Stalin: A Study in Twentieth-Century Revolutionary Patriotism* (London: Routledge Curzon, 2002), p. 290.
53. J. A. Getty, G. T. Rittersporn, and V. N. Zemskov, “Victims of the Soviet Penal System in the Pre-War Years,” *American Historical Review* 98 (1993): 1017–1049; S. G. Wheatcroft, “The Scale and Nature of German and Soviet Repression and Mass Killings, 1930–45,” *Europe-Asia Studies* 48 (1996): 1319–1353; S. G. Wheatcroft, “More Light on the Scale of Repression and Excess Mortality in the Soviet Union in the 1930s,” *Soviet Studies* 42 (1990): 355–367; S. G. Wheatcroft, “Victims of Stalinism and the Soviet Secret Police: The Comparability and Reliability of the Archival Data. Not the Last Word,” *Europe-Asia Studies* 51 (1999): 315–345.
54. A. G. Walder, “Marxism, Maoism, and Social Change: A Re-Examination of the ‘Voluntarism’ in Mao’s Strategy and Thought,” *Modern China* 3 (1977): 125–160.
55. In a well-known speech at the Yen’an forum, for instance, Mao argued that “‘the theory of human nature’ which some people in Yen’an advocate as the basis of their so-called theory of literature and art puts the matter in just this way and is wholly wrong.” M. Tse-Tung, *Selected Works of Mao Tse-Tung*, vol. 3 (Peking: People’s Publishing House, 1960), p. 90.
56. My friend psychologist Dan Gilbert argues that to ask whether morality is outside us is a riddle that traps the mind; it’s like asking, “Is it longer to New York City or by bus?” It’s a riddle that has proved to be quite provocative, however.
57. D. C. Lahti and B. S. Weinstein, “The Better Angels of Our Nature: Group Stability and the Evolution of Moral Tension,” *Evolution and Human Behavior* 26 (2005): 47–63.
58. D. Hume, “Concerning Moral Sentiment,” appendix 1 in *An Enquiry Concerning the Principles of Morals* (London: A. Millar, 1751), p. 289.
59. Taken from a documentary featuring a conversation between Iris Murdoch and David Pears that was part of the TV series *Logic Lane* (1972), directed by Michael Chanan; cited in N. Krishna, “Is Goodness Natural?,” *Aeon*, November 28, 2017, <https://aeon.co/essays/how-philippa-foot-set-her-mind-against-prevailing-moral-philosophy>.
60. R. M. Hare, *The Language of Morals* (Oxford: Clarendon Press, 1952).
61. D. Gilbert, *Stumbling on Happiness* (New York: Knopf, 2016).
62. P. Foot, cited in R. Hursthouse, *On Virtue Ethics* (Oxford: Oxford University Press, 2002), p. 196. See also P. Foot, “Does Moral Subjectivism Rest on a Mistake?,” *Oxford Journal of Legal Studies* 15 (1995): 1–14.
63. Foot, “Does Moral Subjectivism Rest on a Mistake?”
64. A. H. Maslow, “A Theory of Human Motivation,” *Psychological Review* 50 (1943): 370–396.

Notes

65. A. H. Maslow, *The Farther Reaches of Human Nature* (New York: Viking, 1971), p. 279.
66. H. Shirado and N. A. Christakis, “Locally Noisy Autonomous Agents Improve Global Human Coordination in Network Experiments,” *Nature* 545 (2017): 370–375. In this experiment, involving four thousand people in 230 groups working together to solve a coordination problem, we evaluated what happened when we secretly placed some artificial-intelligence bots within the groups. How do people behave when they are part of a hybrid system made up of humans and machines? We found that if the bots acted in certain ways (paradoxically, if we deliberately made them just a little bit imperfect in their decision-making), the real humans did not mind their presence and actually performed better.
67. M. L. Traeger, S. S. Sebo, M. Jung, B. Scassellati, and N. A. Christakis, “Vulnerable Robots Positively Shape Human Conversational Dynamics in a Human-Robot Team” (unpublished manuscript, 2018). Other work by roboticist Brian Scassellati’s research group has shown that embedding a robot in a group can affect how an autistic child communicates not only with the robot but also with other humans. E. S. Kim et al., “Social Robots as Embedded Reinforcers of Social Behavior in Children with Autism,” *Journal of Autism and Developmental Disorders* 43 (2013): 1038–1049.
68. E. Awad et al., “The Moral Machine Experiment,” *Nature* 563 (2018): 59–64.
69. Or perhaps, after it becomes more common to have sex with humanoid robots, people will modify how they have sex with each other.
70. D. Silver et al., “Mastering the Game of Go with Deep Neural Networks and Tree Search,” *Nature* 529 (2016): 484–489; D. Silver et al., “Mastering the Game of Go Without Human Knowledge,” *Nature* 550 (2017): 354–359.
71. J. D. Sander and J. K. Joung, “CRISPR-Cas Systems for Editing, Regulating, and Targeting Genomes,” *Nature Biotechnology* 32 (2014): 347–355. More generally, see J. Enriquez and S. Gullans, *Evolving Ourselves: How Unnatural Selection and Nonrandom Mutation Are Changing Life on Earth* (New York: Current, 2015).
72. J. Hughes, *Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future* (New York: Basic Books, 2004); J. Harris, *Enhancing Evolution: The Ethical Case for Making Better People* (Princeton, NJ: Princeton University Press, 2007). In November 2018, a Chinese scientist announced that he had used CRISPR technology to edit the genomes of a pair of twin girls so as to disable a pathway that HIV uses to infect cells. Though the girls appear to have been born healthy, this first use of CRISPR to edit the human germline provoked an international outcry. See D. Cyranoski and H. Ledford, “Genome-Edited Baby Claim Provokes International Outcry,” *Nature* 563 (2018): 607–608.
73. This word is very rarely used, and prior uses are not quite like mine. For instance, Daniel Bell uses the term to describe the act of explaining the evolution of the meaning of sociological concepts in D. Bell, “Sociodicy: A Guide to Modern Usage,” *American Scholar* 35 (1966): 696–714. Pierre Bourdieu appears to use it to explain how ideology works to justify a then-current state of affairs in P. Bourdieu, “Symbolic Power,” *Critique of Anthropology* 4 (1979): 77–85.
74. S. A. Pinker, *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress* (New York: Viking, 2018).