

# THE SELFISH GENE AS A PHILOSOPHICAL ESSAY

Daniel C. Dennett

One critic complained that my argument was ‘philosophical’, as though that was sufficient condemnation. Philosophical or not, the fact is that neither he nor anybody else has found any flaw in what I said. And ‘in principle’ arguments such as mine, far from being irrelevant to the real world, can be *more* powerful than arguments based on particular factual research. My reasoning, if it is correct, tells us something important about life everywhere in the universe. Laboratory and field research can tell us only about life as we have sampled it here<sup>1</sup>.

**P**ROBABLY most scientists would shudder at the prospect of having a work of theirs described as a philosophical treatise. ‘You really know how to hurt a guy! Why don’t you just say you disagree with my theory instead of insulting me?’ But Richard Dawkins knows better. He is just as leery of idle armchair speculation and hypersnickety logic-chopping as any hardbitten chemist or microbiologist, but he also appreciates, as the passage above makes admirably clear, that the conceptual resources of science need to be rigorously examined and vividly articulated before genuine understanding, sharable by scientists and laypeople alike, can be achieved. Dawkins’ contribution on this conceptual front is philosophy at its best, informed by a wealth of empirical work and alert to the way subtle differences in expression can either trap a thinker in an artifactual cul-de-sac or open up new vistas of implications heretofore only dimly imagined. My high opinion of his philosophical method is hard for me to separate, of course, from my deep agreement with the conclusions and proposals he

arrives at. But this is not inevitable; there are few experiences more unsettling to a philosopher than watching a non-philosopher stumble into agreement with one's most carefully executed conclusions by a sort of lucky drunkard's walk. Dawkins, in contrast, is impressively surefooted.

I didn't read *The Selfish Gene* when it came out in 1976 because of some negative comment I ran into—I can't recall from whom—to the effect that the book was too clever by half, a bit of popularizing that could well be ignored. So I am deeply grateful to Douglas Hofstadter for undoing the damage of that bum steer fairly soon, in 1980, when he and I were working on our anthology, *The Mind's I*,<sup>2</sup> in which we included two excerpts, under the title 'Selfish Genes and Selfish Memes'. (Several times in my life I've taken the word of somebody I regarded well and moved a new book onto my 'don't bother' list only to discover later that this was a book that properly belonged on my 'read immediately' pile. We are all overwhelmed with competitors for our limited attention, so we really have no choice but to trust some filters and hope for the best, but it is distressing to find in retrospect that we have almost missed a close encounter of the finest kind. Ever since then I have tried—with marginal results, I'm sure—not to be dismissive of books unless I am really sure that they are time-wasters.)

I was a committed Darwinian before I got around to reading *The Selfish Gene*. My 1969 book *Content and Consciousness*,<sup>3</sup> and my essays, 'Intentional Systems',<sup>4</sup> and 'Why the Law of Effect Will not Go Away',<sup>5</sup> have Darwinian moves at their heart, for instance. But I actually knew very little about the fine points of the theory, and some of what I thought I knew was just wrong. *The Selfish Gene* delighted me from beginning to end, instructing and correcting me on dozens or hundreds of important points and confirming my inchoate sense that evolution by natural selection was the key to solving most of the philosophical problems I was interested in. This was mind candy of the highest quality. I have never looked back, as one says, so when I was invited to write an essay for this volume, it struck me that looking back would indeed

be a good idea. Although I had often assigned large parts of the book in my classes, I hadn't reread it in one go, and now that I had spent a solid quarter-century delving into the controversies of evolutionary theory (and reading just about everything else that Dawkins has written, along with untold numbers of books and essays by other evolutionists and their critics), I wondered if it would still strike me as brilliant, or would I now see flaws, oversimplifications, solecisms that escaped my naive reading? Having climbed the ladder, would I now want to discard it?

So I took a copy along on a two-week trip, in June 2005, to the Galápagos, for a cruise arranged by the historian of science, Frank Sulloway (whose work had upset the traditional myth of Darwin's *eureka* moment while on the Beagle), followed by the World Summit on Evolution organized by the Universidad San Francisco de Quito, held on San Cristóbal Island. I would be spending my days in conversation with some of the world's best evolutionary biologists, and I'd be rereading *The Selfish Gene* while sailing from island to island, in Darwin's footsteps. I didn't take my heavily underlined and annotated 1976 edition, but my almost equally heavily underlined and annotated 1989 edition, with all the endnotes and the two additional chapters. What follows are my reflections on this rereading, most of them composed on my laptop in the salon of Sagitta, a gracious three-masted schooner, while riding at anchor in one or another of the Beagle's stopping places in the Galápagos. With all the intellectual and perceptual competition, this would be a stern test for any book.

What struck me most was that my deep appreciation of Dawkins has been strengthened, not diminished, by the intervening years of evolutionary adventures. I found myself in rousing agreement with Dawkins' opening passage: 'We are survival machines—robot vehicles blindly programmed to preserve the selfish molecules known as genes. This is a truth which still fills me with astonishment.'<sup>6</sup> As he went on to say in the preface to the 1989 edition,<sup>7</sup> the theorists whose work he celebrates in the book had clearly articulated this truth, 'But I found their expressions of it too laconic, not full throated enough'. What Dawkins

saw was that Darwin's scientific revolution was also a philosophical revolution: 'Zoology is still a minority subject in universities, and even those who choose to study it often make their decision without appreciating its profound philosophical significance.'<sup>8</sup> Indeed. Darwin's dangerous idea amounts to nothing less than a reframing of our fundamental vision of ourselves and our place in the universe. Stephen Jay Gould once branded us both as 'Darwinian fundamentalists',<sup>9</sup> and in spite of the negative connotations Gould intended to convey by that epithet, there is a sense in which he was right. *This* is the fundamental truth of Darwinism, and, as I have tried to show in my own work, there are no stable intermediate positions; either you shun Darwinian evolution altogether and cling to an Aristotelian or Abrahamic vision of God as Prime Mover and Creator, or you turn that traditional universe upside-down and accept that mind, meaning, and purpose are the fairly recent *effects* of the churning mechanistic mill of mindless Darwinian algorithms, not their *cause*. Design is generated originally by bottom-up processes, and all the top-down processes of research and development that we know so well (human authorship and exploration, invention, problem-solving, and creation) are themselves the evolved fruits of these bottom-up processes at many levels and scales, including Darwinian algorithmic processes within individual brains. All the attempts at compromise, at making exemptions for one cherished treasure or another by hanging it on a skyhook, are doomed to incoherence.

I was invited by Dawkins to write an Afterword for the new edition (1999) of *The Extended Phenotype*, and I opened that brief essay much as I have opened this one, by applauding both the philosophical methods and the very considerable philosophical substance of that work.

Why is a philosopher writing an Afterword for this book? Is *The Extended Phenotype* science or philosophy? It is both; it is science, certainly, but it is also what philosophy should be, and only intermittently is: a scrupulously reasoned argument that opens our eyes to a new perspective, clarifying what had been murky and ill-understood,

and *giving us a new way of thinking* about topics we thought we already understood.<sup>10</sup>

This and other published instances of commendation earned me the epithet ‘Dawkins’ lapdog’ from Gould. Huxley was happy to call himself Darwin’s bulldog, and Dawkins has shown that he can be his own bulldog, so I’d be happy to be known as a hard-working sled dog on the same team as Dawkins; but enough about dogfights. Our agreement is deep and detailed, and I give him credit for some of the issues we chime together on, but on some others I got there on my own. What matters is not who got what first, but that our convergent versions support each other, gaining strength from the different paths by which we arrived at them.

Most centrally, consider our *mentalistic behaviorism*. If you think that’s a contradiction in terms, you’ve missed the boat. To see why, you have to appreciate an earlier scientist/philosopher friendship, between B. F. Skinner and W. V. O. Quine. Fred Skinner’s brand of behaviorism was a philosophically driven methodology: according to him, mind-talk in all its varieties was dualistic and *mysterian* (to speak anachronistically, using Owen Flanagan’s useful term). Science was to be materialistic, and mechanistic, and hence should abjure all use of mentalistic idioms.<sup>11</sup> Never speak of an animal as *knowing* or *wanting* or *believing* or *expecting*. Speak instead of an animal’s dispositions to behave (where the behavior was to be described in scrupulously mechanistic terms—no *seeking* behavior or *investigating* behavior, for instance. His Harvard colleague and friend Van Quine appreciated Skinner’s impatience with unsupported mind-talk, and sharpened that puritan ethic by analyzing mind-talk as logically pathological: the *intentional idioms* of mentalistic discourse exhibited the awkward feature of ‘referential opacity’. (In a sentence such as ‘Tom believes that Tully denounced Catiline’, you can’t ‘substitute equals for equals’ by putting in ‘Cicero’ for ‘Tully’—two expressions referring to the same individual—and be sure that you will preserve the truth, as you can always do in a

normal, referentially transparent sentence.) In a famous phrase, Quine joined forces with Skinner and threw down the gauntlet:

One may accept the Brentano thesis [of the irreducibility of intentional idioms] either as showing the indispensability of intentional idioms and the importance of an autonomous science of intention, or as showing the baselessness of intentional idioms and the emptiness of a science of intention. My attitude, unlike Brentano's, is the second.<sup>12</sup>

This abstemious brand of behaviorism, apparently the straightforward extension of what we might call standard scientific positivism, had widespread influence in the second half of the twentieth century, but meanwhile another sort of behaviorism was developing, which helped itself blithely to a few well-chosen intentional idioms—mainly *expect* and *prefer* (or, equivalently in philosopher-speak, *believe* and *desire*)—and built up impressive edifices of theory and practice, in decision theory and game theory, in economics and computer science and cognitive science, and farther afield. This was close kin to the 'logical behaviorism' informally explored by Gilbert Ryle in *The Concept of Mind*.<sup>13</sup> Although it is unclear whether Ryle had much influence outside philosophy, his coupling of staunch anti-Cartesianism (the notorious 'ghost in the machine') with an insouciant disregard of the Skinnerian strictures opened the conceptual floodgates. The key idea, as he saw, was that mentalistic terms were a convenient way of speaking of *dispositions* to behave, and more particularly behavioral *competences* or *abilities*. When one spoke of somebody's knowledge or expectation, goals or preferences, one was alluding not to some spooky, metaphysically private inner goings-on, but to a pattern of (mainly intelligent) *action* that could be expected from this agent. Although Ryle concentrated on human minds, the extension of this perspective to other natural phenomena, both 'higher' and 'lower', was more or less guaranteed by the substrate-neutrality or abstractness of any such dispositional analysis: handsome is as handsome *does*, and anything that can behave *as if striving* for this and that while guided by what it '*knows*' is an appropriate subject for such an analysis.

So, just as a person could be confirmed to be *vain* by observing how she tended to act when in the presence of mirrors or potential admirers (without our having to look into her soul for some imagined vanity-nugget), a gene could be *selfish* without our having to impute any consciousness or ‘qualia’ or other dubious mental furniture to it: ‘It is important to realize that the above definitions of altruism and selfishness are *behavioural*, not subjective. I am not concerned here with the psychology of motives.’<sup>14</sup> Dawkins’ brilliant application of mentalistic behaviorism—what I call the *intentional stance*—to evolutionary biology was, like my own coinage, an articulation of ideas that were already proving themselves in the work of many other theorists. We are both clarifiers and unifiers of practices and attitudes pioneered by others, and we share a pantheon: Alan Turing and John von Neumann on the one hand, and Bill Hamilton, John Maynard Smith, George Williams, and Bob Trivers on the other. We see computer science and evolutionary theory fitting together in excellent harmony; it’s algorithms all the way down.

Dawkins and I have both had to defend our perspective against those who cannot fathom—or abide—this *strategic* approach to such deep matters. Mary Midgley<sup>15</sup> was incredulous—how on earth could a gene be *selfish*?—while John Searle<sup>16, 17</sup> was equally scornful—anybody who says a thermostat has a *belief* about the temperature must be crazy! Mere *as if* intentionality or *derived* intentionality could never explain our *real, original* intentionality. But the appropriate response to this incredulity is the same response that any biologist should make to a similar challenge about where to ‘draw the line’ between the living and the non-living: ‘Should we call the original replicator molecules “living”? Who cares?’<sup>18</sup> One of the central lessons of Darwinian thinking is that essentialism must be abandoned: the imagined ‘essence of life’ has to be approached by one imaginable chain or another of simple agents or agencies stretching from the clearly non-living to the clearly living, and only a lexicographical *decision* is going to ‘draw the line’. There are better and worse joints at which to carve nature, but they are better only in that they make life easier for the

theorist. As we climb the scale from utterly mindless (but selfish) genes through almost equally mindless (but still striving) macro-molecular mousetraps to ingeniously designed (but still clueless) fledgling cuckoos to clever apes (and robots) to wonderful, mindful *us*, if anyone asks us the question ‘But which of these intentional systems have *real* minds?’ the answer is: ‘Who cares?’ There couldn’t be ‘real’ minds and ‘real’ selfishness without billions of years of hemi-semi-demi-pseudo-proto-quasi-minds and mere ‘as if’ selfishness to drive the research and development process that has eventually yielded our minds. Now we can look back: our paradigmatic minds and purposes can be used as our model—sometimes literal, sometimes metaphorical, sometimes semi-literal/semi-metaphorical—for the processes that populated the ancestral phenomena. The same virtual regress can be played out synchronically by treating a human mind (for instance) as a ‘society of minds’<sup>19,20</sup>—lesser intentional agencies competing and cooperating in the ongoing task of maintaining a *soul* to govern a body, and those clever striving agencies are made up of simpler agencies in turn, and so on until we get to functionaries so simple and mindless that they can be replaced by a machine.

‘Yes, we have a soul; but it’s made of lots of tiny robots!’<sup>21</sup>—and it was designed by a Blind Watchmaker. Championing such vivid oxymorons is not just a rhetorical habit that Dawkins and I share; it is a deliberately designed assault on the default presumption of the pre-Darwinian world: the trickle-down vision in which all Design must come from a greater, higher Mind, instead of bubbling up from mindless, motiveless mechanisms.

One of the insights I gained from rereading *The Selfish Gene* in the context of the World Summit on Evolution was that it is not just the Midgleys and Searles who are uncomfortable with Dawkins’ anthropomorphizing of genes; there are eminent evolutionary scientists who still yearn for a biological version of stripped-down Skinnerian/Quinian behaviorism. They may not know just why they are unwilling to speak, with Dawkins, about what the Blind Watchmaker has *discovered* over and over again (in convergent evolution), and they fully appreciate the aptness of



Orgel's Second Rule (evolution is cleverer than you are), but they feel a little guilty indulging in such talk, even in the squeaky-clean contexts of evolutionary game theory. (On several occasions in discussion with such self-styled hardheads I have been put in mind of the philosopher Sydney Morgenbesser's reaction to such puritanical overkill: 'Let me see if I've got this straight, Prof. Skinner: you're saying it's a mistake to anthropomorphize *humans*?' The Skinnerians did seem to think that in order to be properly scientific they had to pretend that people were stupid, since after all, at bottom, people are made of nothing but atoms and atoms are stupid. And some evolutionists still seem to think that they have to refrain from using the oft-proven fact that natural selection can be relied upon to *find* the best move in the design problems set for it.<sup>22</sup> Yes, at bottom, evolution is a mindless, purposeless, mechanistic process, but at higher levels of analysis, it can be seen to be teeming with agent-like entities engaged in competitions, exploring possibilities, solving problems, discovering designs.)

Dawkins, unlike many scientists—and most philosophers—is comfortable with definitions that lack the hard edges of necessary and sufficient conditions. Even the central concept of a gene, he claims, can get by on 'a kind of fading-out definition, like the definition of 'big' or 'old'.<sup>23</sup> Is this really acceptable? Philosophers have a way of starting off down a promising path and then stopping after the first few steps and spending the rest of their time and energy worrying about some problem of definition or an assumption that they might better just grit their teeth and *make*! Dawkins goes on: 'A gene is not indivisible, but it is seldom divided.'<sup>24</sup> That is what makes it a gene, in fact: its salience over longish periods of time. (That is, it is the salience over time of a particular undivided but still varying sequence that makes it the case that *there is something there worth reidentifying and naming*.) 'The gene is defined as a piece of chromosome which is sufficiently short for it to last, potentially, *for long enough* for it to function as a significant unit of natural selection.'<sup>25</sup> But notice that it is not a particular hunk of DNA Dawkins is talking about: philosophers would say he's talking about a *type* not a *token*.

(Two tokens of the word type 'talking' occur in the previous sentence. When I say that 'talking' is a two-syllable word, I'm talking about the type, not any particular token.) Dawkins puts the point this way: 'What I am doing is emphasizing the potential near-immortality of a gene, in the form of copies, as its defining property.'<sup>26</sup> So genes are like words, or like novels or plays, or melodies. A particular play, such as *Romeo and Juliet*, exists in many tokens, on stages and in books, on videotapes and DVDs. A particular gene also exists in many tokens, in trillions of cells. This is Dawkins' way of making George Williams' point that the gene is the *information* carried in the base pairs, not the base pairs themselves, which are like the trails of ink (or acoustic waves or laser-readable DVD pits). What counts as the gene is not just any canonical reading of the text but also all the mutant misreadings that are clearly misreadings *of this text*.

Dawkins is equally pragmatic in his treatment of animal signals. Some theorists have wondered if we can ever say exactly what any animal signal *really* means, or what any animal is *really* thinking, but Dawkins wisely avoids committing himself to this hysterical realism: 'If we wish to (it is not really necessary), we can regard signals such as the cheep call as having a meaning, or as carrying information . . .'.<sup>27</sup> Alarm calls 'could be said to carry information'.<sup>28</sup> While I approve of this reluctance to be drawn into definitional battles, such reluctance can be carried too far, leading one to overlook or underestimate important differences. For instance, in his brief discussion of a lecture he attended by Beatrice and Allen Gardner, trainers and keepers of the famous signing chimpanzee Washoe,<sup>29</sup> he mentions, disparagingly, the philosophers at the lecture who 'were very much exercised by the question of whether Washoe could tell a lie'. He suspects that the Gardners thought there were more interesting things to talk about, and says he agreed with them. It was not important, he suggests, to inquire into whether Washoe could tell a deliberate lie, knowingly and consciously intending to deceive. What was interesting, he suggests, is just creating an 'effect functionally equivalent to deception'.

Angler fish wait patiently on the bottom of the sea, blending in with the background. The only conspicuous part is a wriggling worm-like piece of flesh on the end of a long 'fishing rod', projecting from the top of the head. When a small prey fish comes near, the angler will dance its worm-like bait in front of the little fish, and lure it down to the region of the angler's own concealed mouth. Suddenly it opens its jaws, and the little fish is sucked in and eaten. The angler is telling a lie, exploiting the little fish's tendency to approach wriggling worm-like things. He is saying 'Here is a worm', and any little fish who 'believes' the lie is quickly eaten.<sup>30</sup>

This is true, and a fine use of the intentional stance, but it is also true that deliberate lies are on a different plane from the functional deception of angler fish. There are many intermediate cases of quasi-knowing deception in animals—the distraction displays of such low-nesting birds as piping plovers are a well-studied instance<sup>31</sup>—as well as a bounty of tempting anecdotes about the 'Machiavellian' intelligence of primates.<sup>32</sup> In fact the question of whether Washoe could tell a deliberate lie is a deeply interesting theoretical question, investigated at length with another chimpanzee, Sarah, by David Premack and his colleagues, and leading to some intermittently fruitful and important research on both animals and children, the ill-named 'theory of mind' controversy.<sup>33</sup> The transition from mindless deceit to mindful deceit is a good manifestation of a major transition in evolution—not a metaphysical or cosmic distinction, an unbridgeable chasm, but a passage, with intermediate transitional cases of deceit that may not be so mindless. Once that transition has been clearly accomplished, it opens up a whole new world of deceit (and other sophisticated behavior). Dawkins recognized this himself in his commentary in *Behavioral and Brain Sciences* on 'Intentional Systems in Cognitive Ethology',<sup>34</sup> so this is not a point of ongoing disagreement.

In fact, of course, Dawkins' insight into the role of cultural evolution in designing the minds of one species of primates, *Homo sapiens*, has been a major influence on my own work. The concept of a meme, a replicating unit of cultural evolution that

can move from brain to brain, redesigning the brain a little to make it a better outpost for itself and other memes, opens up ways of thinking about psychological phenomena—both cognitive and emotional—that were inaccessible to earlier theorists puzzling about the problems of consciousness. Now that we have the idea, it even seems obvious, in retrospect, that most of the huge difference between our minds and the minds of chimpanzees is not due directly to the genetically controlled differences in neuroanatomy but to the vast differences in *virtual* architecture made possible by those minor differences in the underlying neural hardware. By becoming adapted to the transmission and rehearsal (internal replication) of a cornucopia of pre-designed cultural thinking tools, our brains became open-minded in a way that is apparently unavailable to chimpanzee brains no matter how intensively their cultural environment is enriched.

At this time, the contributions of the concept of a meme are still largely conceptual—or philosophical. The search for testable hypotheses of memetics is still in its infancy, but there are more than a few applications of the underlying insights to theoretical problems in philosophy, cognitive science, and more recently, the nature of ethics and religion.<sup>35</sup> For instance, I recommend Balkin's *Cultural Software*,<sup>36</sup> and my own book on religion as a natural phenomenon, *Breaking the Spell*.<sup>37</sup> The creation of a new scientific concept is like speciation: you can't identify a successful instance at the moment of birth. Time will tell whether, in another century, Dawkins' chapter on memes will be retrospectively crowned as the birth of an important scientific lineage of work. I am betting on it, but what about my claim that the book is excellent philosophy in any case? A psychologist colleague, on reading a draft of this essay, asked if *The Selfish Gene* is considered required reading in any philosophy graduate program. Certainly specialists in the philosophy of science or philosophy of biology would be expected to have read it, but what about students of epistemology or philosophy of mind or language? We philosophers are a somewhat conservative lot, loath to grant that anybody but a professional philosopher could write something

worthy of entry into the canon. If you put *The Selfish Gene* on the *required* reading list, just which ‘classic’ would you bump from the list to make room for it? I have seen enough philosophy students enthusiastically tell me how they were transformed by reading the book to judge that it pulls its weight and then some, so yes, I put Dawkins’ book alongside classics by such non-philosophers as Turing<sup>38</sup> and Kuhn<sup>39</sup> as essential thinking tools for any student of philosophy. In addition to everything else they will learn from it, they will discover that it is actually possible to write arguments that are both rigorous and a joy to read. That discovery, if enough philosophers took it to heart, could transform our discipline.

## ENDNOTES

- 1 Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 2nd edn., 1989), 322.
- 2 Douglas R. Hofstadter and D. Dennett, *The Mind’s I: Fantasies and Reflections on Self and Soul* (New York: Basic Books, 1981).
- 3 Daniel Dennett, *Content and Consciousness* (London: Routledge & Kegan Paul, 1969).
- 4 Daniel Dennett, ‘Intentional Systems’, *Journal of Philosophy*, 68 (1971): 87–106.
- 5 Daniel Dennett, ‘Why the Law of Effect Will not Go Away’, *Journal for the Theory of Social Behaviour*, 5 (1975): 169–187.
- 6 Dawkins, *The Selfish Gene* (1st edn., 1976), v.
- 7 Dawkins, *The Selfish Gene* (2nd edn., 1989), ix.
- 8 Dawkins, *The Selfish Gene* (2nd edn., 1989), 1.
- 9 Stephen Jay Gould, ‘Darwinian Fundamentalism’, *New York Review of Books* (12 June 1997), 34–37 and ‘Evolution: The Pleasures of Pluralism’, *New York Review of Books* (26 June 1997), 47–52.
- 10 Daniel C. Dennett, ‘Afterword’, in Richard Dawkins, *The Extended Phenotype* (Oxford: Oxford University Press, 1999).
- 11 For a detailed analysis of Skinner’s position, see Daniel C. Dennett, ‘Skinner Skinned’, in *Brainstorms* (Cambridge, MA: MIT Press, 1978).
- 12 Willard Van Orman Quine, *Word and Object* (Cambridge, MA: MIT Press, 1960), 227. Quine acknowledged the ‘practical indispensability’

in daily life of the intentional idioms of belief and desire but disparaged such talk as an 'essentially dramatic idiom' rather than something from which real science could be made in any straightforward way (*Word and Object*, page 217), but later in his career he came to appreciate that this dramatic idiom might be harnessed into a predictive science. My own very Quinian analysis of the philosophical problems of referential opacity and their dissolution can be found in two essays: Daniel C. Dennett, 'Beyond Belief' and 'Mid-term Examination: Compare and Contrast', in *The Intentional Stance* (Cambridge, MA: MIT Press/Bradford, 1978).

- 13 Gilbert Ryle, *The Concept of Mind* (London: Hutchinson, 1949).
- 14 Dawkins, *The Selfish Gene* (2nd edn., 1989), 4.
- 15 Mary Midgley, 'Gene-juggling', *Philosophy*, 54 (1979): 439–458.
- 16 John Searle, *Minds, Brains and Science* (Cambridge, MA: Harvard University Press 1985).
- 17 John Searle, *The Rediscovery of the Mind* (Cambridge, MA: MIT Press, 1992).
- 18 Dawkins, *The Selfish Gene* (2nd edn., 1989), 18.
- 19 Marvin Minsky, *Society of Mind* (New York: Simon & Schuster, 1985).
- 20 George Ainslie, *Breakdown of Will* (Cambridge: Cambridge University Press, 2001).
- 21 'Si abbiamo un anima. Ma è fatta di tanti piccolo robot.' Giulio Giorelli, quoted in Daniel C. Dennett, *Freedom Evolves* (London: Penguin, 2003), 1.
- 22 Richard Lewontin has often insisted that it is a mistake to assume that lineages are posed problems by the environments they encounter, and since a wealth of adaptationist success stories belies this claim, it is tempting to conclude that Lewontin views all these results as ill-gotten gains. For a discussion, see Richard Lewontin, 'Elementary Errors about Evolution', *Behavioral and Brain Sciences*, 6 (1983): 367–368 and Daniel C. Dennett, (1983), my response to his response.
- 23 Dawkins, *The Selfish Gene* (2nd edn., 1989), 32.
- 24 Dawkins, *The Selfish Gene* (1989), 33–34.
- 25 Dawkins, *The Selfish Gene* (1989), 35–36.
- 26 Dawkins, *The Selfish Gene* (1989), 35.
- 27 Dawkins, *The Selfish Gene* (1989), 63.
- 28 Dawkins, *The Selfish Gene* (1989), 64.
- 29 Dawkins, *The Selfish Gene* (1989), 64.
- 30 Dawkins, *The Selfish Gene* (1989), 64–65.

- 31 C. Ristau, 'Aspects of the cognitive ethology of an injury-feigning bird, the piping plover', in C. Ristau (ed.), *Cognitive Ethology: The minds of other animals* (Hillsdale: LEA, 1991).
- 32 Andrew Whiten and R. Byrne (eds.), *Machiavellian Intelligence* (Oxford: Oxford University Press, 1988) and *Machiavellian Intelligence, II: Extensions and Evaluations* (Cambridge: Cambridge University Press, 1997).
- 33 Daniel C. Dennett, 'Beliefs about Beliefs' (commentary on Premack, Woodruff, et al.), *Behavioral and Brain Sciences*, 1 (1978): 568–570.
- 34 Richard Dawkins, 'Adaptationism was always predictive and needed no defense', *Behavioral and Brain Sciences*, 6 (1983): 360–361. Commentary on Daniel C. Dennett, 'Intentional Systems in Cognitive Ethology: The "Panglossian Paradigm" Defended', *Behavioral and Brain Sciences*, 6 (1983): 343–390.
- 35 For a survey of the status and progress of memetics, see Daniel C. Dennett, 'The New Replicators', in Mark Page (ed.), *The Encyclopedia of Evolution* (Oxford: Oxford University Press, 2002), vol. 1, E83–E92.
- 36 J. M. Balkin, *Cultural Software: A Theory of Ideology* (New Haven: Yale University Press, 1998).
- 37 Daniel C. Dennett, *Breaking the Spell* (London: Penguin, 2006).
- 38 A. Turing, 'Computing Machinery and Intelligence', *Mind*, 59 (1950): 433–460.
- 39 Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

# RICHARD DAWKINS

HOW A SCIENTIST CHANGED  
THE WAY WE THINK

*Reflections by scientists, writers, and philosophers*

Edited by  
ALAN GRAFEN  
AND  
MARK RIDLEY

OXFORD  
UNIVERSITY PRESS



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Great Clarendon Street, Oxford OX2 6DP

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Published in the United States  
by Oxford University Press Inc., New York

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British Library Cataloguing in Publication Data  
Data available

Library of Congress Cataloging in Publication Data  
Data available

Typeset by RefineCatch Ltd., Bungay, Suffolk  
Printed in Great Britain by  
Clays Ltd., St Ives plc

ISBN 0-19-929116-0 978-0-19-284055-8

1 3 5 7 9 10 8 6 4 2