COMMENTARY

Evolution Isn't Teleological, Writing About it Is

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Abstract

Some critics hold that all talk of functions, purposes, goals, and intentions should be outlawed in biology: they are teleological notions and therefore misleading or inappropriate. But it is difficult to write non-teleologically about evolution (or anything) because language and narrative are suffused with agency and intent and therefore teleology. I offer a reading of several works of colloquial science to illustrate the various conceptions of teleology in biology and the futility of trying to purge discourse of teleological framings. In natural language, the subject–object constituents and certain features of verbs carry connotations of intent even when they describe a mindless process, such as natural selection. Narrative, meanwhile, works by implying that agents (with goals) are what weave together the unspecified connections between events. Combined, the constraints of language and narrative guarantee that authors will be accused of teleology even while arguing, often convincingly, against teleology in evolution.

Keywords: Teleology, evolution, popular science, colloquial science, narrative, agency, language.

Highlights

- Teleology is either external or internal *and* either intentional or non-intentional.
- Gene editing (CRISPR) and the universe's heat death present novel cases.
- Language itself is optimized to convey agency, contributing to teleological framings.
- Narrative is an inherently teleological mode, invoking agents as unseen causes.

1. What counts as teleology?

Evolution by natural selection is an unguided process. Darwin and Wallace, by explaining the history of life as being without purpose and marked instead by chance and contingency, thereby annihilated teleology in nature.

That's the official story. But people frequently use the same words to mean different things. A few modern biologists, just

as secular as the celebrity Darwinians, actually honour Darwin (and Wallace, when they remember) for bringing teleology into the scientific fold. In this version, natural history is still contingent, but the astonishing complexity of living things is a testament to their ability to achieve goals; unlike rocks and stones, trees manage to survive and reproduce thanks to a non-supernatural teleology.

Historians, philosophers, and scientists have explored an ever ramifying space of positions on the legitimacy or not of teleology in biology.[1] Much of it seems to boil down to semantics. But it may be more a case of syntax. Teleology, of some kind, is inescapable because of features that are baked-in to ordinary speech and writing. For that reason, I examine texts that are written by experts but aimed at a broader public. Colloquial science books are arguably the main channel through which non-experts encounter descriptions of Darwinian evolution and attendant notions of teleology.[2] In these texts, teleology does not figure in terms of fine-grained conceptual distinctions or debates about how words should be used. It appears in the authors' less guarded terms — often various, sometimes contradictory within the same work — as part of their larger efforts to entertain and to offer framings of evolution that engage readers. This is apropos because teleology is ubiquitous in biological discourse precisely because of issues of framing. The narrative form and the medium of natural language are both bound up with communicating goals, agency, and intent: telltales of teleology. The way evolution is framed in popular discourse is guaranteed to elicit accusations of teleological explanation. This provides an open field for examining why it may be unavoidable — not for metaphysical or scientific reasons but discursive ones.

My approach is interdisciplinary, uniting several threads of scholarly literature. Some haven't been applied to this topic before, like the cognitive science of animacy detection, narratology, and the linguistics of agency. Others are well-trod, such as the philosophy of biology, and the rhetoric of science. Following a brief survey of some representative forms of teleology from the genre, I offer some suggestions about *why* teleological explanation is so compulsive. Drawing on insights from cognitive science and narratology, I suggest the snare is not a lack of philosophical or scientific rigor, but features that are inherent to written expression.

Rather than rehearse a tangled literature on teleology, I begin with a fairly standard distinction which is still illuminating: *external teleology* versus *internal teleology* (sometimes called immanent teleology). I choose this starting point simply because it corresponds roughly to the ways teleology is talked about in colloquial texts. External teleology concerns a larger purpose or goal governing the course of the world, typically a divine intelligence. Internal teleology is about a particular person, organism, or part of the world that has a goal or end towards which its actions are directed. Illustrating the internal–external dichotomy, James Lennox contrasts the historical examples of Plato and Aristotle.[3] In the Platonic mode, there is a design to the universe put there by some rational being such as a universal Mind or the demiurge. The Aristotelian notion of *telos*, however, concerns a goal or end inherent in a thing's nature; the thing exists *for the sake of* that goal or end.

These versions of teleology have equivalents in modern understandings of biological evolution. The external version has it that life as a whole is progressing towards some endstate or goal, either set by a divine agency or as a destiny written into the universe itself. The internal version says that an organism, or even a particular trait of an organism, exists for some goal or end, an *entelechy* or *telos* of its own. This is often couched in less blatantly purposive language: a trait performs a

function, or is an *adaptation to* an environment. Such talk of function or adaptation is sometimes acknowledged as a purely practical device not implying any metaphysical weight and the word *teleonomy* is often used to distinguish the mere appearance of purposiveness from the actual purposiveness of teleology proper.[4]

Generally speaking, mainstream biologists and others writing colloquial science strongly abjure external teleology while tolerating or even endorsing internal teleology, at least in the guise of teleonomic or adaptationist language. For this reason it can be confusing to read criticism or praise of this or that writer as being "teleological" in their treatment of evolution, if the type of teleology is not specified. But even with the external–internal dichotomy in place, there are still positions articulated in colloquial texts that are not captured but which seem to be teleological according to other definitions. For example, a writer may disavow any notion of progressive evolution (external teleology) and attack adaptationist language (internal teleology) but also proclaim strict determinism and the eventual heat death of the universe. In other words, they criticise two received types of teleology and yet advance a view that in effect says, "Everything happens for a reason," and, "All things are moving towards an inevitable end state".[5] This seems to be a teleology of some kind, so the term needs further unpacking.[6]

Rather than adjudicating definitional debates, I map out an array of views about evolution in the works of recent colloquial science that in one way or another might be labelled teleological. I aim to be descriptive rather than prescriptive. To aid the rest of the discussion, I suggest one slight complication to the external–internal dichotomy. It is useful to think in terms of two variables that, in different pairings, yield four types of teleology (see Table 1 below). A teleological framing of evolution can be either internal or external *and* either intentional or non-intentional. One could make more intricate distinctions.[7] But this one has the virtue of emanating from the set of texts I read, rather than some pre-existing framework.

The usefulness of the intentional–non-intentional variable is evident when current understandings of teleology involve people using the same words to argue diametrically opposed views. Take Richard Dawkins. He is devoutly anti-teleology and repeatedly states in his popular works that evolution has no foresight and that it produces only the appearance of design, the mere illusion of creatures being shaped *for* their environment.[8] And yet he is accused of being incorrigibly teleological by the renowned plant scientist David Hanke. Hanke upbraids Dawkins for his teleological explanations, which are symptomatic of how "biology is sick" with "unscientific modes of thought".[9] To demonstrate this, Hanke provides samples from Dawkins' writings, sans context: "Only the germ-line cells, it would seem, really *need to* preserve the entire genome. It may be that *the reason* is simply that there is no easy way, physically, to hive off parts of the genome".[10] I have added emphasis to the teleological traces here, for readers less vigilant than Hanke. This discloses a very stringent standard for purging teleological language from biological explanation. Dawkins has not used more blatant phrases like *selected for* or *in order to*: the typical language of adaptation, held by many to be an acceptable, internal, form of teleological explanation, if only for linguistic convenience. The mere reference to a need or a reason in a biological system incurs Hanke's diagnosis. With this standard in place, virtually all biological discourse, including textbooks and technical papers, would be classified as teleological. Dawkins, who even coined the term *designoid* to refer to objects that seem designed — namely, living things — might be surprised to learn that he is a teleologist par excellence. Something is

clearly amiss.

Dawkins' works are certainly popular and his writing on evolution is as close to a public face of Darwinism as one could find. Hence Hanke's concern. He warns that if we need examples of sloppy teleological explanation we can "read anything written by the first Oxford Professor of the Public Understanding of Science".[11] Nor is colloquial science neatly cut-off from "serious" science. Although Dawkins is frequently maligned for being more of a science communicator or science journalist — evidently terms of abuse — than a scientist, *The Selfish Gene* (2016) is the most cited work of evolutionary biology of the twentieth century.[12] On its publication in 1976 it was praised by as serious a biologist as John Maynard Smith for making an original contribution to biology, in the guise of a trade book.[13] Colloquial science authors also rely on one another for expertise in different fields. Of the authors canvassed below, even the professional scientists among them get some of their science from other colloquial works.[14] This isn't the place for a full accounting of the cultural influence of the colloquial science genre. But it certainly reaches more readers than the technical literature; it is a popular choice of medium for highly successful and professionally influential biologists; it provides a forum where authors can be more expansive and unguarded in their worldviews; and it is exemplary for communicating in an exoteric style aimed at persuasion and engagement.

I begin with a cross-section of views from recent colloquial science and produce a fuzzy-edged typology of teleological explanations of evolution. In the sections following that, I propose that features of language and narrative may oblige authors to write about evolution in ways that suggest teleology, despite their best efforts, and that doing so is likely unavoidable.

2. Teleology in colloquial science

In our neo-Darwinian world, overt cases of external teleology — evolution guided by God's will — are absent from mainstream textbooks. But they can be found in colloquial works by authors advocating Intelligent Design. Michael Behe is the most well known, and his recent work *Darwin Devolves* (2019) is a trade book of popular science that includes an explanation of Darwinian evolution, albeit in service of an Intelligent Design-based argument. Behe is open about God being the driver of evolution, writing that, "Contemporary nature, especially people, is largely intended — the product of a preexisting reasoning mind," and that this is a teleological world, in which the "first person to have discussed the likelihood of teleology — purpose — in nature was a Greek named Anaxagoras".[15] This final remark reminds us that Behe and likeminded authors adhere to both external and internal teleology.

Even among mainstream authors —*i.e.* those who do not advert to religious or supernatural explanations for biological phenomena — external teleology can be found. Robert Wright's *Nonzero* (2001) posits an entirely naturalistic but nonetheless global directionality to evolution. The logic of non-zero sum games, argues Wright, can explain the growth in complexity over time, including biological and cultural evolution. This is teleological as it entails evolution exploring the space of possibilities and increasing its own ability to do so.[16] Wright is aware of how outré this type of thinking is. He notes that both grand narrative style history and teleological approaches to evolution are out of fashion, but pursues his

progressive evolutionary outlook anyway, suggesting that although living things cannot have teleological drives — he forbids internal teleology — perhaps the overall process of evolution can.[17]

Since Wright's book in 2001, the publishing phenomenon of Big History has seen a revival of progressive natural history and a return to grand evolutionary narratives. The *evolutionary epic* (or epic of evolution) is a large scale narrativization of history, starting with the Big Bang or the origin of life and usually culminating in either the advent of *Homo sapiens* or the writing of the epic itself.[18] Evolutionary epicists incorporate teleological framings of large scale evolution, overlaying a moral and anthropomorphic meaning to a vast and impersonal process.[19] Ursula Goodenough, for example, wrote *The Sacred Depths of Nature* (1998) as a deliberate exercise in creating a secular creation myth and the prominent biologist E.O. Wilson has endorsed the idea in colloquial works.[20]

Otherwise, external teleology in the traditional sense is rare, but internal teleology thrives in popularisations that employ the language of adaptation, function and (non-supernatural) design. The philosopher Daniel Dennett's *From Bacteria to Bach and Back* (2017) has a section discussing the validity of teleology in biological explanation. He declares that, although there is no supernatural teleology in living systems, the language of adaptation, function, and design is indispensable, especially given the backdrop of the rise of Intelligent Design:

> *Which battle do we want to fight? Do we want to try to convince lay people that they don't really see the design that is stunningly obvious at every scale in biology, or would we rather try to persuade them that what Darwin has shown is that there can be design — real design, as real as it gets — without an Intelligent Designer?*[21]

Following this rationale, Dennett says Darwin's theory provides a way to rationally talk about teleology without resorting to the divine or supernatural. He concludes: "Darwin didn't extinguish teleology; he naturalised it".[22]

The above are reasonably clearcut examples of either internal or external teleology, but there are other viewpoints that sit uneasily in this dichotomy. *A Crack in Creation* (2017) by Jennifer Doudna and Samuel Sternberg is about the gene editing technology, CRISPR, of which Doudna was a leading developer. The book also provides a standard introduction to Darwinian evolution and basic genetics. Then, in a section devoted to ethical issues raised by the technology, the authors identify CRISPR as a new form of evolution, one that goes beyond what Darwinian evolution has hitherto been capable of: "Indeed, we are already supplanting the deaf, dumb and blind system that has shaped genetic material on our planet for eons and replacing it with a conscious, intentional system of human-directed evolution".[23] The words *conscious*, *intentional* and *human-directed* all suggest a type of internal teleology in excess of the notions of function or adaptation that are standardly accorded to genes. But this is not external teleology in any sense, as it is only the goals of humans, specifically genetic engineers, that are represented.[24]

Another kind of overt internal teleology, one that also goes beyond Dennett's strategic use of the word, can be found in Stuart Kauffman's *A World Beyond Physics* (2019). Kauffman opens by acknowledging the generally non-teleological nature of the world, writing that "Classical physics, our gift from Newton, is written in the passive voice," and that in this regime, "There are no doings, only happenings".[25] But in biology, scientists describe *doing* rather than mere happening: a

world beyond physics. "Such systems literally construct themselves," writes Kauffman, and "evolve to create biospheres no one can prestate, governed by no entailing law at all… life is thus reinhabited by a renewed and fully natural and nonmystical form of vitalism".[26] Although it is nonmystical, Kauffman's vitalism is arguably intentional. His recent books have presented the evolution of complex life as being the evolution of agency. The *self-organising* organism (a tautology for Kauffman) emphasises, with its gerund, not just happening but doing. This is a primitive case of internal teleology, not because it is linguistically convenient to speak of organisms *as though* they shape their environment for their own ends, but because in Kauffman's rendering the organism *does* shape its environment for its own ends and this is precisely what distinguishes the living from the nonliving, doing from happening.[27]

For the philosopher of biology Alex Rosenberg, however, there is nothing beyond physics and therefore no teleology even of the non-supernatural type. His *Atheist's Guide to Reality* (2011) has a somewhat misleading title. It is really a popular introduction to the implications of naturalism as a philosophy, and much of the book is colloquial science, in the form of expositions of thermodynamics and Darwinian evolution. Rosenberg says these two strands of modern science preclude any notion of teleology or purpose whatever: "[Physics] firmly bans all explanations that are *teleological*… It's hard to see how there could be purposes or teleology in a physical universe governed by the second law [of thermodynamics]... the universe is headed to complete disorder. For the universe as a whole, the only end state is its heat death".[28] This covers off any external teleology like what is found in Intelligent Design-inspired books or evolutionary epics. But Rosenberg goes further and adopts a similar stringency to internal teleology, just like Hanke. Here he is discussing the seeming goal-directedness of an ant colony's behaviour:

> *I had to guard myself from employing terms like "in order to," "for the sake of," "so that." I didn't entirely succeed... The resulting social institutions of herding, protecting, farming, milking, and cultivating that the colony organizes demand a teleological, goal-directed view of nature. Or, rather, they would demand it if not for the fact that they were all the result of blind variation and environmental filtration.[29]*

Any apparent internal teleology is only a mirage and should not be acknowledged even for explanatory convenience. Rosenberg opts for the non-intentional phrase "environmental filtration" over "natural selection," in an effort to avoid the teleological connotations that date even to Darwin's use of the term *selection*.[30]

Rosenberg is a self-described "mad-dog naturalist" who has sought to purge *all* teleology from his worldview, and yet, depending on definitions, even his account of evolution arguably contains teleological elements. Rosenberg says the end-state of the universe is known and everything, including evolution, is heading inexorably toward it. Indeed evolution, with its wasteful production of many more highly ordered organisms than can possibly survive, is identified as the most entropy-producing process in the universe.[31] The future outcomes of Darwinian evolution are therefore subsumed into the fate of the universe as a whole, as dictated by the Second Law of thermodynamics: heat death. This could be construed as a kind of external teleology, although obviously not one that is divinely directed. Moreover, Rosenberg's commitment to the laws of physics as being "causally complete" means that in this universe everything happens for a causally legible reason and absolute determinism reigns.[32] This is not what is usually meant by external teleology either. But outright

determinism and an inevitable future outcome for the universe could be taken as a fated outcome, of a non-supernatural kind. A further discrimination is needed, however, because this is unlike Wright's non-supernatural external teleology, where the process of evolution gradually explores its own creative purpose as it builds on successive layers of complexity. In Rosenberg's explanations of physics and biology, the universe has no kind of intent or even tendency to be creative or constructive. Only the blind laws of physics obtain and, as an occasional byproduct, some complexity appears by way of Darwinian evolution, given the right conditions. It is the lack of intention — divine or natural, external or internal — in Rosenberg's worldview that distinguishes it even from other secular authors like Wright, Kauffman, Dennett, or Goodenough.

Table 1 summarises the types of teleology outlined above with some colloquial books exemplifying each type. There are more complex typologies of teleology that take into account more conceptual nuances. Perlman, for instance, has a graph of different positions that is more detailed.[33] I endorse his classifications. But he is mapping the explicitly articulated views of philosophers, not the views of writers that are more public-facing and who represent the way evolution is taught and narrated.[34] My aim is to show how colloquial accounts of evolution contain a range of teleological views that might surprise scholars who have focused on the views of philosophers and historians (even though two of the authors, Dennett and Rosenberg, are well known philosophers of biology).

Table 1. Types of teleology found in colloquial explanations of evolution		
	External	*Internal*
Intentional	Theistic and/or progressive. • Michael Behe's *Darwin Devolves* • Ursula Goodenough's *Sacred Depths of Nature* • Robert Wright's *Nonzero*	Self-organisation, gene editing, artificial selection. • Jennifer Doudna's *Crack in Creation* • Stuart Kauffman's *A World Beyond Physics*
Non-intentional	Determinism, heat death as ultimate fate. • Sean Carroll's *The Big Picture* • Alex Rosenberg's *Atheist's Guide to Reality*	Adaptation, teleonomy: metaphorical teleology. • Jerry Coyne's *Why Evolution is True* • Various Richard Dawkins • Daniel Dennett's *From Bacteria to Bach and Back*

Given the range of views in this matrix, it is hard to conceive of a non-teleological explanation of evolution. This lays bare how problematically broad and polysemous the term *teleology* is. Perhaps the narrative theorist H. Porter Abbott is correct when he argues that the only really accurate, and non-teleological, way to explain evolution is via a mixture of equations, graphs, and other data types.[35] Only such non-narrative, indeed non-linguistic, formats can capture the true nature of the distributed, impersonal processes underlying the evolution of life on Earth, without stumbling into a framing that sounds teleological. I doubt that even these non-linguistic representations can *fully* convey the nature of evolution — whatever that would be like. Abbott is certainly right that the way evolution gets explained in popular prose accounts is typically with the aid of various narrative strategies. But on this point I go further and claim that there is in fact a relationship between the

narrative forms in which evolution is standardly conveyed and the seemingly inescapable teleology that infuses such texts. Before exploring what narratology can offer an analysis of teleology in evolution, I first examine how language itself also biases authors towards making their explanations teleological.

3. How language contributes to teleology

It would be difficult to write a popular introduction to evolutionary science without resorting to at least some form of internal teleology, for ease of reading. We saw how Rosenberg had to flag his difficulty in avoiding phrases like *in order to* and in doing so used them to help explain how natural selection works. It may be impossible for stricter formal reasons too. Natural language encodes in its grammar certain frames of understanding. Specifically, grammar makes it easiest to relate actions as being performed by agents, even inanimate ones, rather than being self-caused or uncaused.[36]

This happens first by way of the subject–object constituents in language. The subject typically *does* something *to* the object or *construes* the object in a certain way, both of which assume the subject is an agent acting deliberately, often with motives, purposes, beliefs, or desires. The object of a sentence, however, can be couched as having none of these attributes, merely by their grammatical role (*i.e.* appearing after the verb of a sentence, at least in English and other SVO languages). Different verbs also distinguish between events that simply happen in a passive and physical way versus those which are caused to happen by agents or *agonists*.[37] They reflect an intuitive view of how animate and inanimate objects act in the world, known as *force dynamics*.[38] Overall, the syntax of human language seems geared towards expressing the actions of agents in the form of *who did what to whom*.[39]

The easiest way to show how purely grammatical features of language can suggest more or less teleological situations, is with the familiar distinction between the passive and active voice. I can use the active voice and say, "I made a mistake," or be evasive and render the same event in a passive construction: "Mistakes were made." The latter suggests the event has simply happened, whereas the former implies agency and deliberate action and therefore culpability. Standard advice to writers is: avoid the passive voice. Although the passive voice is sometimes indispensable, it seems to be true that the active voice is more engaging, probably because of how we intuitively parse novel events as being caused by agents.[40]

Returning to popularisations of evolutionary science, the most well known and best studied is Richard Dawkins' *The Selfish Gene* (2016). Scholars have debated the use of personification in the title and just how metaphorical an entity is the gene.[41] On the one hand, Dawkins writes that a gene for a certain trait "manipulates the other genes for its own selfish ends".[42] "Ends" happens to be a teleonomist's watchword, but the key here is *manipulates* which is a verb strongly connoting intent. But *any* verb that figures the subject of the sentence (in this case the gene) as an agent or agonist acting on others, is evoking not just a metaphorical idea of agency but a basic way to understand complex causality in the world.[43]

Dawkins recognises that active and passive voices represent two utterly different presentations of biological evolution:

> The true "purpose" of DNA is to survive, no more and no less… Evolution is the process by which some genes

> *become more numerous and others less numerous in the gene pool. It is good to get into the habit, whenever we are trying to explain the evolution of some characteristic, such as altruistic behaviour, of asking ourselves simply: What effect will this characteristic have on frequencies of genes in the gene pool? At times, gene language gets a bit tedious, and for brevity and vividness we shall lapse into metaphor. But we shall always keep a sceptical eye on our metaphors, to make sure they can be translated back into gene language if necessary.[44]*

When Dawkins says that evolution is a "process by which some genes become more numerous" he is using a passive construction. This is opposed utterly to the active constructions that follow from the title and central metaphor of the work: the selfish gene, a figure that seems to have agency, that works to achieve certain strategies in order to propagate itself. What Dawkins refers to in the passage as "gene language" is simply the kind of passive construction that is in some ways more true to the nature of evolution, but is awkward in our language, with its tilt towards who did what to whom.

The active language of selfish genes, and even the phrase *natural selection*, is not intended to conjure the image of some rational, purposive agent directing evolution. Dawkins' use of scare quotes around "purpose" rams home this point. Even so, such language engages us and is less "tedious" because it frames events as being caused, however implicitly and inadvertently, by agents. Dawkins elsewhere refers to the "respectable terms" of gene language and the "sloppy language" of metaphor.[45] But he is keenly aware that sloppy language is required to hold a reader's attention and he assumes that readers understand the metaphorical nature of the selfish gene. Hanke's comments, and the critiques of others over the years, suggest that Dawkins' use of the more teleological, albeit metaphorical, framing is not uncontroversial. Debra Journet has noted that Dawkins mixes words that describe mere motion with others that imply action: a suggestive parallel here with the difference between Kauffman's physics of happenings and biology of doings.[46] Nor is it obvious that writers of colloquial science can avoid active language and still sell books, leading to a selection effect in publishing whereby we should not expect to find explanations of evolution completely purged of teleological language; even if they were possible, they would not be popular.

The figure of the selfish gene is in fact an instance in a larger class of metaphors that colloquial science writers use to anthropomorphise nonhuman subject matter. Such personification works seamlessly with the active voice, as in *The Selfish Gene*. The easiest way to fashion a sentence about biological evolution as active, is to personify the species, organisms, or genes it is about. This can happen to a greater or lesser extent. Across the genre, nonhuman organisms — and even sub-organism entities like cells, genes, proteins, or viruses — are standardly personified either in obviously metaphorical terms or with more subtly anthropomorphising language. Even inanimate objects are usually personified. For example, the science writer Natalie Angier does so with subatomic particles: "The electron, with a designated minus sign tattooed on its forehead, finds the positive proton terribly attractive, and wants to spend its time somewhere in the vicinity of one".[47] Readers don't encounter this passage and mistake electrons for having motives. Nor would they arrogate to the electron some kind of internal teleology. But in writing about evolution, with organisms that embody (mindless) strategies, we enter a zone of ambiguity where the use of personification is not entirely metaphorical.[48] Simple organisms, or even unthinking genes, can be described *as though* they have volition, even if the writer does not think so; but unlike the case of electrons, readers may have some basis for thinking the volition is real.

Compare the innocuous phrase *water finds the path of least resistance* with the more contentious *natural selection finds the fittest organisms*. Both describe passive processes by using the verb *find* in the active voice (the subject of the sentence performs the verb). Both thereby lend themselves to teleological readings. Because the second one is in a domain likely to arouse our detection of agency, it is more likely to be read teleologically.

4. How narrative contributes to teleology

Zooming out from the level of the sentence to the level of the discourse, features of narrative likewise funnel these colloquial texts towards teleology. Just as language is infused with our propensity to see events in agential terms, so too is the narrative form. It might actually be more accurate to say we apply the label *narrative* to any representation of events that lends itself to being interpreted in agential terms. Narrative is the form that emerges when we construe a sequence of events as being caused by agents.[49]

Consider the difference between a simple list or chronicle of events and a prose account of those same events.[50] The chronicle offers some resistance to being interpreted in agential terms: a reader will have to work harder to supply the causal and agential glue to bind the events.[51] The prose account will openly refer to people's actions and choices in shaping events, provided it's not an account by academic historians who are deliberately eschewing the narrativisation of history. Although, even then, because of the abovementioned ways that language is weighted towards conveying agency, the prose account will still read as having intentional or teleological overtones, even in a text denuded of overt narrativity. This will explicitly provide the connections we already strive to infer with the list. The more effortlessly we can construe the events as being caused by agents, the less resistance a text offers to being interpreted in such ways and the more *narrativity* it evinces.

Note that this is just one approach from narratology and is roughly aligned with the influence of cognitive science on narratology in the last twenty years, following the structuralism that prevailed in the 1970s and 1980s. It is appropriate here because it attempts to explain why narrative has such an appeal across genres and media.[52]

There are overt and subtle ways in which colloquial science texts are rendered in narrative, even though they are nonfiction texts. Most overtly, many popular science texts employ stock narrative forms. These include the use of tropes from the detective or crime genre, to plot scientific discovery as the collection of clues with the denouement revealing the new scientific consensus; or the hero myth is invoked, with the scientist standing up to the dragons of received dogma; or, in evolutionary texts in particular, the use of just-so stories and fables explain how some trait or organism came to be; and, as already mentioned, the genre of the evolutionary epic recycles many of the features of creation myths. These are all fairly obvious and largely deliberate ways in which colloquial science texts are presented in narrative forms more commonly associated with fictional genres. There are subtler effects of narrative too. Readers naturally and ineluctably perceive sequences of complex events as being connected by the actions of agents. Paradigm cases of narrative include fictions that are crafted to be interpreted this way: crime novels, soap operas, well-made plays, superhero movies. But even nonfiction texts that have no obvious candidates for characters or plot, and which do not adopt or parody fictional

narrative forms, can be seen as simply having *less* narrativity than these paradigm cases, rather than not being narratives at all. They have some narrativity because readers are apt to read into them a storyline: a reasonably coherent sequence of events linked by the doings of agents or pseudo-agents.

To explain why this kind of narrativity is teleological, I need to cover some brief points from the relevant cognitive science. First, agents making things happen, the skeleton of narrative, involves action-at-a-distance as opposed to action-on-contact. Work in the psychology of perception shows that even children as young as nine months old have roughly two styles of interpreting moving objects: causal and teleological.[53] *Causal* means in terms of transparent physical causes in line with how inanimate objects move: a rock falls into a pond and causes a splash *upon contact*. *Teleological*, here, means purposive movement, redolent of animate things, especially humans and other animals. Teleological explanations are associated with causation-at-a-distance because not only do animate objects move, seemingly, towards some intended goal, but they can affect other objects' motion from a distance or be affected from a distance by other objects' motion: the rabbit flees when I arrive, even though I don't make contact.[54]

This style of explanation is a component of the theory of mind which is the habitual, heuristic understanding of minds that humans use in modelling and predicting the actions of other agents, chiefly other humans.[55] Agents are assumed to have beliefs about the world and desires about what they want, both of which shape the actions they perform. The scientific consensus is that we over-apply this faculty and err on the side of attributing agency even in borderline or misleading cases; even scientists trained in physical, non-teleological understandings of the world, still backslide into teleological, mind-laden explanations of complex phenomena, including natural selection.[56]

All of this — teleological explanation, causation-at-a-distance, and an inveterate theory of mind — can help explain the dominance of narrative as an explanatory mode. Narratives connect events but do so in a non-exhaustive way. Not all of the causal connections between events are spelled out in comprehensive mechanistic detail. Although a narrative may have more explicit links than a chronicle or list, narratives remain fundamentally schematic. The connections between events are largely inferred by readers, viewers, or listeners who assume they are caused by the actions of agents. This assumption, that unspecified connections are owing to agents' intentional actions, obviates the need to exhaustively narrate every detail. In our evolutionary past, anything complex enough to be related in a narrative was, perforce, something involving agents. This sounds like a sweeping claim but is really a trivial fact: the only kinds of event sequences that *do not* involve agencies are the kinds that are nowadays dealt with in certain branches of natural science, where a purely mechanistic, domino-like series of causal connections is the desired if not achieved level of understanding. Although the vast majority of events that unfold in the universe are of this non-agential kind, they occupy a vanishingly small share of the topics of human discourse now, let alone in pre-scientific times. Hence, offstage, unseen events are automatically associated with purposive action.

Any motion, in the broadest sense, more complicated than falling dominoes — and therefore just about everything in biology visible to the naked eye — will be assumed to have a teleological explanation: an agent is making it happen for some end. This activates our theory of mind which effortlessly parses complex events in terms of agents with beliefs and desires. Narratives give incomplete summaries of events and in doing so imply distal causal connections among those

events. Such causation-at-a-distance invokes our model of intentional agents and therefore our theory of mind.[57]

To see the connections among events that are non-contiguous in *space* we use our perception of animate objects to infer agential cause. For connections among events that are non-contiguous in *time*, we use our theory of mind and assume that agents are responsible, being the only things that carry memories and execute plans over time.[58] This is problematic when we want a summary of events remote from one another in time but which do *not* entail agents' plans and goals. Any account of such events that details utterly agentless processes will still trigger our theory of mind merely because it is the way we knit together events that we did not witness.

For this reason I demur from previous commentators who have argued that it is the vast, interconnected and emergent nature of evolution as a process that makes it unnarratable.[59] That certainly seems like an insurmountable impediment to a total *explanation* of evolution. But consider that if one did have access to an exhaustive list of events on micro- and macro-scales comprising natural history as a whole, mere exhaustiveness does not make a narrative. In fact, it sabotages it. A narrative is made by having connections between the events rendered interesting, partly by having agents as their implied causes. This is what we normally mean by drama. An exhaustive account of events leaves no room for implied causes. A *complete narrative* of evolution (or anything else) would be an oxymoron.

Even a nonfiction account of a topic like Darwinian evolution, which allegedly banishes at least external teleology, is liable to be interpreted in teleological terms merely because it is in a narrative. Even apart from structural and generic features — like the anticipation of an ending whenever we read, or the narrative tropes already mentioned — any prose account of the hugely complex events involved in evolution will have to compress and summarise. The overall process of Darwinian evolution can be narrativised. This is not because evolution literally entails intentional actions by the organisms and species that evolve. It is because the explanation of such a process will be schematic yet coherent and will lean on our insatiable need to see agencies behind complex happenings — happenings which we read as doings.

5. Is teleology unavoidable?

It would seem to be impossible to avoid all four of the rough types of teleology found in colloquial texts. The external–intentional type, exemplified in books by Intelligent Design advocates or versions of the evolutionary epic, is doubly teleological. It imputes an overall *telos* to the universe (theistic or otherwise) and implies that this is the result of some large agency, either a god or some global tendency towards increasing order. In the secular case of evolutionary epics, we read them as progressive because the only way to read such a coherent story about complex, widely separated events is by assuming some causation-at-a-distance.

Authors writing about the internal–intentional type (where sites of agency like gene editing or self-organisation are posited) are doomed to represent evolution in teleological terms, despite sincere disclaimers from the authors. Relating a process of Darwinian evolution from the perspective of a genetic engineer, or an organism that is *trying* to preserve itself and reproduce itself, is a narrative with coherent events that are linked — as doings, not just happenings — by a veritable protagonist. For hardliners, like Hanke, such texts are unequivocally teleological.

The external–non-intentional form of teleology is the most contentious. Its exponents are themselves staunch opponents of teleology, aiming to expunge it from biology and the rest of science. Yet the mere relating of the process of Darwinian evolution, in a narrative-like form, lends it a teleological aspect. Evolution is shown in such texts to be a fulfillment of the second law of thermodynamics and a contributor to the heat death of the universe and the global dissipation of order. But even as stark and purposeless a framing as that nonetheless presents a storyline: the beginning, middle, and preordained end of life on our planet and elsewhere. Such a summary account of a vast yet intricate series of events, arranged into a simple arc, involves the same lure of narrativity as the external–intentional type, even as it rejects such framing.

Finally, internal–non-intentional (teleonomic) accounts are already criticised by Hanke and other hardliners as being teleological. The language of adaptation or teleonomy is meant to be metaphorical, such that genes are only figuratively "for" various traits which have evolved "in order to" solve a particular problem. But regardless of caveats from Dawkins and his allies, the metaphors do their job anyway. The use of active language, optimised to communicate about agents, will subtly suggest teleology in any case.

Interestingly, all of the types are prey to receptions that apparently do not bedevil physicists or chemists. I cannot find any Hanke-style criticisms of writers explaining nonliving phenomena in agential language, even though that should warrant stronger censure, given there is not even the excuse of teleonomy. Examples like the one from Angier given above — the personification of particles — are apparently so obviously metaphorical or so clearly not an intimation of anything supernatural, that they fail to arouse any objections. And, perhaps it goes without saying, explanations of purposive human behaviour almost never attract criticism; although, Rosenberg bites the bullet and argues that even conscious, volitional human acts are also only metaphorically teleological. And he admits that explanations of human behaviour are impossible without resorting to our theory of mind, until a new vocabulary can be developed, one stripped of all intentional and teleological terms.[60] The nature of language and the ubiquity of narrativity would seem to militate against that possibility, making it hard to imagine a verbal but teleology-free explanation of evolution, or anything else, that is engaging or popular.

Teleology, on the most severe view, is unavoidable in any prose explanation of evolution. It is probably unavoidable in a prose explanation of anything, even something as shorn of teleological language as a mechanistic account of particles. Ironically, this may be for evolutionary reasons. Our minds and our languages simply did not evolve to deal with totally agentless systems. Our ancestors most likely didn't live or die according to their reports of falling dominoes, billiard ball collisions, or chemical reactions. The machinations of agents were more vital.

Disagreements over what teleology means, even within the community of fairly like-minded writers on evolution, guarantee that some authors will be accused of teleological framings even in texts that explicitly deny teleology. Using the strictest definitions of teleology, all popular works on evolution violate such a standard. This is because *any* written account of evolution will necessarily elicit some kind of teleology. Not only is the very grammar of natural language saturated with agency and intention, but narrative accounts, including nonfiction explanations of impersonal phenomena, have teleology baked into them.

Footnotes

1 André Ariew, Robert Cummins, and Mark Perlman, eds. *Functions: New Essays in the Philosophy of Psychology and Biology* (Oxford: Oxford University Press, 2002); Nancy Cartwright "Two Kinds of Teleological Explanation," in *Human Nature and Natural Knowledge*, eds A. Donagan, A. N. Perovich and M. V. Wedin (Dordrecht: Springer, 1986), pp. 201–10; Philippe Huneman, "Revisiting Darwinian Teleology: A Case for Inclusive Fitness as Design Explanation," *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 76 (2019): 101188. Ernst Mayr, "Teleological and Teleonomic, a New Analysis," in *Methodological and Historical Essays in the Natural and Social Sciences*, eds Robert S. Cohen and Marx Wartofsky (Dordrecht: Springer, 1974), pp. 91–117; Karen Neander, "The Teleological Notion of 'Function'," *Australasian Journal of Philosophy* 69:4 (1991): 454–468; Mark Perlman, "The Modern Philosophical Resurrection of Teleology," *The Monist* 87:1 (2004): 3–51; Friederike Trommler and Marcus Hammann, "The Relationship Between Biological Function and Teleology: Implications for Biology Education," *Evolution: Education and Outreach* 13 (2020): 1–16.

2 I follow Erika Lorraine Milam in using *colloquial science* in preference to *popular science* or science vulgarisation or other similar terms. Such works may not actually be popular, nor is there a neat division between the audiences of technical papers and trade books. The register of the language used in colloquial science writing is the key factor that gives these writings the potential to communicate beyond the academy. This stylistic approach to defining the genre also allows us to bypass speculation on the author's intended audience and remain agnostic towards the actual audience size or composition. I do still use *popular science* interchangeably, simply to signal that I am capturing the genre people know by that name. See Erika Lorraine Milam, *Creatures of Cain: The Hunt for Human Nature in Cold War America* (Princeton: Princeton University Press, 2019), p. 284.

3 James Lennox, "Teleology" in *Key Words in Evolutionary Biology*, eds Evelyn Fox Keller and Elisabeth A. Lloyd, pp. 324–333 (Cambridge, MA: Harvard University Press, 1992), p. 326.

4 Lennox "Teleology" (above, n.3), p. 331. Again, I don't think this is the most philosophically nuanced or appropriate way of analysing teleology but it is reflective of the public-facing views of scientists. For a subtle historical treatment of the concept see André Ariew, "Platonic and Aristotelian Roots of Teleological Arguments," in *Functions: New Essays in the Philosophy of Psychology and Biology*, eds André Ariew, Robert Cummins, and Mark Perlman (Oxford: Oxford University Press, 2002), pp. 7–32.

For an up to date overview see Colin Allen and Jacob Neal, "Teleological Notions in Biology," in *The Stanford Encyclopedia of Philosophy*, ed. Nick Zalta, (2020), https://plato.stanford.edu/archives/spr2020/entries/teleology-biology/.

5 For an example in colloquial writing see Sean M. Carroll, *The Big Picture* (New York: Dutton, 2016) pp.32–52.

6 How much the heat death of the universe constitutes a teleological view is a topic that needs more exploration. Some creationist authors claim that the unidirectional nature of time imposed by the Second Law is evidence that modern science *is* fundamentally teleological. Mason Tattersall notes that even Lord Kelvin, an originator of the heat death

hypothesis, considered it a vindication of teleological views of the world, including the narrative of the Old Testament, and a riposte to materialism. See Mason Tattersall, "Thermal Degeneration: Thermodynamics and the Heat-Death of the Universe in Victorian Science, Philosophy, and Culture," in *Decadence, Degeneration, and the End*, eds Marja Härmänmaa and Christopher Nissen, 17–34 (New York: Palgrave Macmillan, 2014) p. 20.

[7] Perlman "Resurrection of Teleology" (above, n. 1), pp.149–52.

[8] Richard Dawkins, *The Blind Watchmaker* (London: Penguin, 1986), p. 5; Richard Dawkins, *The Greatest Show on Earth: The Evidence for Evolution* (New York: Free Press, 2009), p.389n.

[9] David Hanke, "Teleology: The Explanation that Bedevils Biology" in *Explanations: Styles of Explanation in Science*, ed.John Cornwell, pp. 143–55 (Oxford: Oxford University Press, 2004), p.143.

[10] Dawkins in Hanke, "Teleology" (above, n. 9), p. 143.

[11] Hanke, "Teleology" (above, n. 9), p. 143

[12] There is a paper on a statistical method for estimating the confidence of a phylogenetic connection that has more citations, but it's questionable as to whether that counts as evolutionary biology as such. In any case, Dawkins' citations are not just other books but hundreds of technical papers. One can find plenty of cases of Dawkins being hit with the "journalist" epithet with a simple Internet search, along with much worse, but sometimes it comes from fellow authors of colloquial works like E.O. Wilson and Nassim Nicholas Taleb.

[13] Richard Dawkins, *The Selfish Gene: 40th Anniversary Edition* (Oxford: Oxford University Press, 2016), p. 463.

[14] This is a ubiquitous practice. Carroll cites Dawkins as a primer on natural selection: Carroll, *Big Picture* (above, n. 5), p. 452. Ursula Goodenough cites Dawkins' and Robert Wright's colloquial works for evolution as well as colloquial texts by the physicists Stephen Hawking and Stephen Weinberg for cosmology: Ursula Goodenough, *The Sacred Depths of Nature* (Oxford: Oxford University Press, 1998) p. 176, p. 178. Stuart Kauffman cites books by the physicist Lee Smolin and Goodenough's book: Stuart Kauffman, *A World Beyond Physics: The Emergence and Evolution of Life* (Oxford: Oxford University Press, 2019) p. 300, p. 305.

[15] Michael Behe, *Darwin Devolves* (New York: HarperCollins, 2019), pp. 1–2.

[16] Robert Wright, *Nonzero* (New York: Vintage, 2001), p.310ff.

[17] Wright, *Nonzero* (above, n. 16), p. 10, p.15.

[18] Ian Hesketh " "The Recurrence of the Evolutionary Epic."*Journal of the Philosophy of History*9:2 (2015): pp. 196–219.

[19] Hesketh "Epic" (above, n. 18), p. 200.

[20] Goodenough, *Sacred Depths* (above, n. 14), pp. xv–xvi; E.O. Wilson*On Human Nature* (Cambridge, MA: Harvard University Press, 1978), p. 201.

[21] Daniel Dennett, *From Bacteria to Bach and Back* (New York: WW Norton & Company, 2017), p. 36.

[22] Dennett, *From Bacteria* (above, n. 21), p. 51.

[23] Jennifer Doudna and Samuel Sternberg, *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution* (New York: Houghton Mifflin Harcourt, 2017), pp. 243–4.

[24] There is a parallel here to artificial selection or breeding, which could also be considered teleological, although it can also be completely non-intentional. It is not included here because it rarely features as a topic in colloquial writing on evolution.

[25] Kauffman, "Beyond Physics" (above, n. 14), p. ix.

[26] Kauffman, "Beyond Physics" (above, n. 14), p. 31.

[27] Huneman also classes self-organisation approaches as examples of intrinsic teleology. See Huneman, "Darwinian Teleology" (above, n. 1), section 3.1.

[28] Alex Rosenberg, *The Atheist's Guide to Reality: Enjoying Life Without Illusions* (WW Norton & Company, 2011), pp. 41–2. Interestingly, in a later passage, Rosenberg comments that "the second law says that nothing is inevitable, even the heat death of the universe"; later still he reaffirms: "Science tells us that the only thing that really is fated is the heat death of the universe" — p. 72, p. 309.

[29] Rosenberg *Atheist's Guide* (above, n. 28), p. 216.

[30] Abdulsalam Al-Zahrani, "Darwin's Metaphors Revisited: Conceptual Metaphors, Conceptual Blends, and Idealized Cognitive Models in the Theory of Evolution," *Metaphor and Symbol* 23:1 (2007): 54–5.

[31] Rosenberg *Atheist's Guide* (above, n. 28), p 77.

[32] Rosenberg *Atheist's Guide* (above, n. 28), p. 236, pp. 308–9.

[33] Perlman, "Resurrection of Teleology" (above, n. 1), p. 151.

[34] Similarly, Mayr has a fourfold typology of teleology but three of the four represent sub-types of the kind of adaptationist stance taken by Dawkins and other professional biologists (Mayr 1974).

[35] H. Porter Abbott, "Unnarratable Knowledge: The Difficulty of Understanding Evolution by Natural Selection," in *Narrative Theory and the Cognitive Sciences*, ed. David Herman (Stanford: CSLI Publications, 2003), p. 160.

[36] Robert M.W. Dixon, "A Typology of Causatives: Form, Syntax and Meaning." In Changing Valency: Case Studies in Transitivity, eds Robert M. W. Dixon and Alexandra Y. Aikhenvald (Cambridge: Cambridge University Press, 2000), pp. 30–83; Leonard Talmy, "Force Dynamics in Language and Cognition." Cognitive Science 12:1 (1988): 49–100. For a colloquial introduction to this and other topics in psycholinguistics, see Steven Pinker *The Stuff of Thought* (New York:

Penguin, 2007).

[37] Note that the agent in a sentence is not always the subject of that sentence. *Subject* in linguistics denotes a purely syntactic role, whereas *agent* is a semantically given role, depending on the verb. Throughout the article I use *agent* not in this linguistics sense, but in a broader sense in line with its use in cognitive science, evolutionary game theory, and everyday speech. For an accessible introduction to all of this see Pinker, *Stuff of Thought* (above, n. 36), p. 197, pp. 219–25

[38] Talmy, "Force Dynamics" (above, n. 36), pp. 91–5).

[39] Pinker, *Stuff of Thought* (above, n. 36), p. 27.

[40] For our agential bias, see Pinker, *Stuff of Thought* (above, n. 36), p.71. The active voice is just one, fairly widely recognised, feature of language that betrays our proclivity for communicating agency. For how visual perception prioritises the movement of agents (active) rather than patients (passive) and how this priority is mirrored in grammatical order, see Karl Verfaillie and Anja Daems, "The Priority of the Agent in Visual Event Perception: On the Cognitive Basis of Grammatical Agent-Patient Asymmetries," *Cognitive Linguistics* 7:2 (1996): 131–147. For work on how the priority of agents in visual, language, narrative and event comprehension is reflective of a deep-seated necessity to track the actions of agents in preference to passive objects, see Neil Cohn, and Martin Paczynski, "Prediction, Events, and the Advantage of Agents: The Processing of Semantic Roles in Visual Narrative," *Cognitive Psychology* 67:3 (2013): 73–97.

[41] Katherine N. Hayles, "Desiring agency: Limiting Metaphors and Enabling Constraints in Dawkins and Deleuze/Guattari," SubStance 30:1 (2001): 144–159; Debra Journet, "The Resources of Ambiguity: Context, Narrative, and Metaphor in Richard Dawkins's *The Selfish Gene*," *Journal of Business and Technical Communication* 24:1 (2010): 29-59; Mary Midgley, "Gene-Juggling," *Philosophy* 54:210 (1979): 439–458; Venla Oikkonen, "Narrating Descent: Popular Science, Evolutionary Theory and Gender Politics," *Science as Culture* 18:1 (2009): 1–21.

[42] Richard Dawkins, *The Selfish Gene 40th Anniversary Edition* (Oxford: Oxford University Press, 2016), p. 56.

[43] Pinker, *Stuff of Thought* (above n. 36), pp. 218–9.

[44] Dawkins, *Selfish Gene* (above, n. 42), pp. 57–8.

[45] Dawkins, *Selfish Gene* (above, n. 42), p. 114.

[46] Debra Journet, "George C. Williams, Kenneth Burke, and 'The Goal of the Fox': Or, Genes, Organisms, and the Agents of Natural Selection," *Narrative* 19:2 (2011): 216–28, at pp. 216–7.

[47] Natalie Angier, *The Canon: A Whirligig Tour of the Beautiful Basics of Science* (New York: Houghton Mifflin Harcourt, 2007), p. 13.

[48] The impact of this feature of language has been noted before with respect to explaining evolution in an educational context, where teleological frames of understanding are hard to eradicate. But it hasn't been offered as a general

impediment to written explanations of evolution. See Ross H. Nehm, Meghan A. Rector and Minsu Ha, "'Force-Talk' in Evolutionary Explanation: Metaphors and Misconceptions," *Evolution: Education and Outreach* 3 (2010): 605–613. See also Gale M. Sinatra, Sarah K. Brem and E. Margaret Evans, "Changing Minds? Implications of Conceptual Change for Teaching and Learning about Biological Evolution," *Evolution: Education and Outreach* 1 (2008):189–195.

[49] In this formulation, not all prose accounts are narratives (or at least do not possess much *narrativity*) if they lack either (i) global coherence, *i.e.* all or most events are related, not simply consecutive events; or (ii) discernible agents. A text lacking global coherence but possessing agents might include a cut-up story, a surreal story, a report of a dream, or a story written by a young child. A text possessing coherence but lacking agents might include a purely expository text, an instruction manual, or a mathematical proof.

[50] The chronicle/narrative distinction is common in narratology as well as in studies of historical narrative. In a now classic article, Hayden White compares annals (just events and dates), to chronologies/chronicles (which have a few more details but which typically break off *in medias res*) and richer narrative accounts of history. See Hayden White, "The Value of Narrativity in the Representation of Reality," *Critical Inquiry* 7:1 (1980): 5–27.

[51] White, "Narrativity" (above, n. 52), p. 16.

[52] For various recent definitions of narrative from within narratology, see Ryan, Marie-Laue. "Towards a Definition of Narrative," in *The Cambridge Companion to Narrative*, ed. David Herman, (Cambridge: Cambridge University Press, 2007), pp.22–35. For a well respected recent account of how narrative is "in the eye of the beholder" and a good example of the "cognitive turn" in narratology, see Yanna B. Popova, *Stories, Meaning, and Experience* (New York: Routledge, 2015), pp.62–4. For specifics on which mental faculties are most important in understanding narrative, see Jamie Milton Freestone "Narrative: Agents Acting at a Distance," *Storyworlds* 11:1 (2019): 25–50.

[53] Deborah Kelemen, Joshua Rottman and Rebecca Seston, "Professional Physical Scientists Display Tenacious Teleological Tendencies: Purpose-Based Reasoning as a Cognitive Default," *Journal of Experimental Psychology: General* 142:4 (2013): 1074; Anne Schlottmann and Luca Surian, "Do 9-Month-Olds Perceive Causation-at-a-Distance?" *Perception* 28:9 (1999): 1105–1113.

[54] Schlottman and Surian, "Causation-at-a-Distance" (above, n. 56), p. 1105.

[55] Sarah-Jayne Blakemore and Jean Decety, "From the Perception of Action to the Understanding of Intention," *Nature Reviews Neuroscience* 2:8 (2001): 561–567.

[56] For the inveterate attribution of agency, see Alex Rosenberg *How History Gets Things Wrong* (Cambridge, MA: MIT Press, 2019), p. 185. For professionals still lapsing into teleological framings, see Keleman *et al.*, "Teleological Tendencies" (above, n. 56); see also Nehm *et al.*, "Force Talk" (above, n. 49).

[57] Schlottman and Surian, "Causation-at-a-Distance" (above, n. 56), p. 1105.

[58] Narrative prompts not only our theory of mind but also our capacity for mental time travel, namely, the ability to project

ourselves in time either backwards (hindsight) or forwards (foresight). Theory of mind helps us understand isolated events as having agential causes. But to join together a sequence of events — often out of chronological order, with a discrepancy between the *fabula* and the *syuzhet* — in a narrative that unfolds over minutes or even hours, we need an additional skill. Mental time travel is the best candidate. See Freestone "Acting at a Distance" (above n, 54).; And for a review of the relevant science, see Francesco Ferretti, Ines Adornetti, Alessandra Chiera, Serena Nicchiarelli, Giovanni Valeri, Rita Magni, Stefano Vicari, and Andrea Marini, "Time and Narrative: An Investigation of Storytelling Abilities in Children with Autism Spectrum Disorder," *Frontiers in Psychology* 9 (2018): 944.

[59] Abbott "Unnarratable" (above, n. 35), pp. 146–7; H. Porter Abbott, "Narrative and Emergent Behavior,"*Poetics Today* 29:2 (2008): 227–244; Oikkonen "Narrating Descent" (above n. 41), pp. 3–5.

[60] Rosenberg, *How History Gets Things Wrong* (above, n. 59), pp. 207–10. This is the position of*eliminative materialism* in the philosophy of mind, which predicts that a future vocabulary, informed by more advanced neuroscience, will supplant our folk vocabulary of intentional beliefs and teleological desires.

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