Biological Journal of the Linnean Society, 2023, **139**, 415–432. With 1 figure.

Resolving teleology's false dilemma

GUNNAR BABCOCK* and DANIEL W. McSHEA

Department of Biology, Duke University, Durham NC 27708, USA

Received 13 January 2022; revised 20 April 2022; accepted for publication 3 May 2022

This paper argues that the account of teleology previously proposed by the authors is consistent with the physical determinism that is implicit across many of the sciences. We suggest that much of the current aversion to teleological thinking found in the sciences is rooted in debates that can be traced back to ancient natural science, which pitted mechanistic and deterministic theories against teleological ones. These debates saw a deterministic world as one where freedom and agency is impossible. And, because teleological entities seem to be free to either reach their ends or not, it was assumed that they could not be deterministic. Mayr's modern account of teleonomy adheres to this basic assumption. Yet, the seeming tension between teleology and determinism is illusory because freedom and agency do not, in fact, conflict with a deterministic world. To show this, we present a taxonomy of different types of freedom that we see as inherent in teleological systems. Then we show that our taxonomy of freedom, which is crucial to understanding teleology, shares many of the features of a philosophical position regarding free will that is known in the contemporary literature as 'compatibilism'. This position maintains that an agent is free when the sources of its actions are internal, when the agent itself is the deterministic cause of those actions. Our view shows that freedom is not only indispensable to teleology, but also that, contrary to common intuitions, there is no conflict between teleology and causal determinism.

ADDITIONAL KEY WORDS: agency – autonomy – compatibilism – determinism – goal directedness – materialism – mechanism – reductionism – teleonomy.

INTRODUCTION

A dilemma troubles scientific thinking on teleology. It arises from a tension between a determinist world view and the notion of freedom that seems essential to the pursuit of goals. The tension was present in discussions of teleology among the ancient Greeks, and it is present in our thinking about teleology today. The tension is that on the one hand, we think of the universe as deterministic. Entities' properties and their outcomes are determined by past events in accordance with natural laws. We know that when billiard balls are struck with a cue stick their trajectories are determined by Newton's laws. With enough information and computing power, we could precisely predict where they will come to rest. On the other hand, it seems as though many things, particularly in biology, behave in predictable ways, but not in ways that seem determined. They are directed towards goals, but their reaching the goals is not assured. Any notion of goal directedness, purpose or teleology seems to require that there be alternative outcomes. Teleology, goal directedness, purposefulness has to do with seeking, with trying, with a struggle to achieve some end that is not destined. Acorns aim at the goal of becoming mature oak trees, but the vast majority of acorns instead end up as squirrel food. In a perfectly deterministic world it seems there can be no struggles, only necessitated outcomes. And it is the possibility of this failure that makes the use of teleological terminology seem apt. It's why, in spite of the efforts by some in biology to rid the field of teleological language, it always seems to come back. If all acorns ended up as robust oak trees, no matter what, what would be the point of using teleological words like 'aim'? A lion tries to catch the gazelle, but it fails to reach that end more often than not. And again the possibility of failure is implicit in the teleological word 'try'. If the lion always caught the gazelle, there would have been no need for it to try. In other words, some possibility of alternative outcomes—of what we will here call freedom—is foundational to genuine teleological explanations. If there are entities that

*Corresponding author. E-mail: gunnar.babcock@duke.edu

are truly teleological, they must have some degree of freedom. In other words, it seems the hallmark of teleology is precisely that teleological entities *aren't* predetermined to reach their ends, that they do it—at least some of the time—without being predetermined. That they do it despite being somewhat free.

Here, we offer an understanding of freedom that is just the sort required for a robust concept of teleology, and that at the same time is consistent with the causal determinism that seems so often to be implicit in the sciences. In essence, we show that freedom, or the capacity for some outcomes to have been otherwise, does not conflict with the idea that the world is completely determined by natural laws. In doing so, we show that one of the primary rationales for purging biology of teleology doesn't support that purge.

Our argument hinges on two core insights. The first is that freedom never meant total freedom, freedom from all constraints. And that is a good thing, because total freedom is unintelligible. A totally free entity would have no properties, no nature, to constrain it, and would have no interactions with its external environment, which would also constrain it. Rather, freedom has always meant freedom with respect to something in particular. Freedom from discrimination, freedom from tyranny, freedom from debt. So what are the things we want freedom from? Usually, it is freedom from some teleological system that we perceive to be harmful or limiting, freedom from teleological structures that would control us, direct us, manipulate us. In the language we will develop shortly, freedom from certain 'fields'. The view developed here includes human freedom, but is far more general. It applies across biology, encompassing freedom in all teleological systems, including organisms, their development and behaviour, and even in their component parts. And it applies across purely physical goal-directed systems, a view of freedom that tells us what it looks like in inanimate things.

The second insight has to do with hierarchy and the sort of freedom that hierarchical structure makes possible, freedom that in deterministic systems is available in no other way. A simple physical example illustrates the principle. A helium-filled balloon, hovering neutrally buoyant in a room, is a hierarchical system consisting of helium atoms inside a plastic skin. Let us suppose that the behaviour of every atom is fully deterministic, that each collision between it and another helium atom or between it and a molecule of plastic is dictated precisely by physical laws. And let us also suppose that the movement of the whole balloon, as it drifts about the room, is fully deterministic such that every movement the balloon makes in response to each small air current has an effect that is dictated precisely by laws. Despite this thorough-going determinism, the atoms of helium are nevertheless free to move about within the balloon, that is, they are free with respect to the balloon as a whole. The movement of the balloon dictates the on-average location of all of the atoms, collectively, as they follow the drifting balloon about the room, but with respect to the balloon, every atom can move anywhere inside it. In this relative sense, made possible by the hierarchical structure of the system, the helium atoms are free.

In the next section, we begin with a short history of the tension between determinism and teleology. Then we turn to a discussion of the foundations of our argument, situating it among the various 'isms' that inevitably pop up in discussions along these lines: mechanism, determinism, materialism and reductionism. In the next sections, we look at alternative ways that freedom can be understood, considered in the context of a theory of goal directed systems that we've offered elsewhere. This theory of goal directedness, which we call *field theory*, reveals that freedom and teleology go hand in hand. Finally we show that this view is compatible with causal determinism and situate our version of compatibilism among the various others that have arisen in philosophical accounts of free will.

DETERMINISM VS. TELEOLOGY

Aristotle's account of teleology is, by most accounts, the most historically influential one. Aristotelian teleology sought to steer between the extremes of Democritus' atomistic materialism and Empedocles' randomness. At the time that Aristotle put forward his teleology there was no view that explicitly argued for what, today, we would call determinism. Such a view would come later from the Stoics. Thus one might wonder why we want to discuss determinism in relation to teleology. The reason is that atomists, like Democritus, to whom Aristotle was responding, saw the world as being composed solely of matter and void, thereby serving as a kind of precursor to today's sciences. Implicit in this atomistic materialism was the idea of a kind of blind necessity, that one material happening necessarily leads to another. Their accounts were also often deemed mechanistic by later thinkers in the 17th century, like Henry More or Robert Boyle, creating a historical link between atomism and mechanism. This atomistic materialism was also embraced by the Epicureans. The Epicureans found the materialist thesis helpful for their ethical arguments, but they also saw its implied determinism as a threat. For this reason Epicurus, and other Epicureans like Lucretius, felt compelled to posit a 'swerve' in the physical arrangement of material, from which they could extract the origin of free will. [See O'Keefe (2021) for a summary of ancient views on free will and determinism, and Long and Sedley's commentary from

The Hellenistic Philosophers, Vol. 1: Translations of the Principle Sources, with Philosophical Commentary (1987)]. So, while it is true that when Aristotle made teleology the centrepiece of his physical and ethical theories there was no explicit statement of what, today, we would call determinism, there is a sense in which this early statement of materialism contained within it the entailment of a deterministic worldview—one to which Aristotle was opposed.

What Aristotle found unpalatable with the atomists' implicit determinism (or complete randomness, depending on the particular account) was that it provided no room for purpose or final causes. On their account, change occurred merely because of the arrangement of physical matter with a bottom-up sort of causal structure. For Aristotle, it was nonsensical to deny that change is directed towards certain ends and that such purposes or ends are not always destined to be reached. One only needs to observe the world around them to see this is true. Whatever metaphysical account is provided of physical causes must include these observations about purposes and ends, must acknowledge that they are present in nature. We will not detail Aristotle's reasoning for why he thought this must be the case, as we're not going to suggest a return to Aristotelian metaphysics. But what is clear is that Aristotle roundly rejected any account of nature that does not make room for purpose.

Thus, on the one side we have Aristotle, defending teleology, purpose and ends. With Aristotle we also find the Epicureans searching for a place where the emergence of free will might have been possible in a purely physical universe. On the other side we have the atomists, whose theories seem to imply a sort of fatalism or determinism and whom Aristotle used as a foil in his account of the natural world full of purpose. The way in which these two views seemed pitted against one another was not lost on thinkers in later antiquity, such as in *On the Natural Faculties* (Galen, 1916),where Galen sees medical theories falling along a divide of being either teleologically based or atomistic.

In modern terms, this way of carving things up sounds wrong. Starting with Thomas Hobbes and David Hume, a different picture has slowly come into focus, one that presents an alternative account of determinism, freedom, and purpose in the world. But we do need acknowledge the ways in which we still live in the debates that we have inherited from the ancients. Democritus' atomism is echoed in the modern sciences, both in the popular mind and tacitly by many scientists.

The introduction to Christian List's *Why Free Will Is Real* (2019) aptly notes the very live tension between the scientific, deterministic world view and ones that see something special in agency and intentionality. The sciences tend to confirm the world is physical, supporting a materialist thesis. Of course, the actual physical makeup of the world has turned out to be quite different from what the atomists imagined, but *the fact that* it's physical aligns with their view. Furthermore, that the world is governed by physical laws again aligns with these early atomist views, though, again, the laws that do the governing are quite different from what the atomists thought. And the mechanistic view of nature has also been widely adopted throughout the modern sciences as well (it is beginning to be questioned), though again, the mechanisms today are not those that the atomists had imagined. Finally, in a fashion not unlike what the Epicureans thought about the atomist's fatalism, today there is an often a sentiment that the sciences tell us the world is deterministic once we leave the quantum realm behind. It seems we've been historically primed to see this sort of determinism, this sort of materialist science as being a threat to purpose and teleology, making the possibility of the two coexisting peacefully look like a non sequitur. But this is precisely what we're going to suggest is possible. First, however, we need to sort through some of the confusion that comes with equating one thesis with another, e.g. mechanism with determinism or materialism with mechanism or what-have-you. The next section will try to organize these theses in a way that allows us to narrowly home in on our targets, avoiding any collateral damage in the form of mistaken claims.

THE 'ISMS': MECHANISM, DETERMINISM, MATERIALISM, REDUCTIONISM

It's easy to saddle the sciences with a blind adherence to the theses of mechanism, determinism, materialism and reductionism. Perhaps the ancients are partly to blame for this. So here, at the outset, we would like to be clear how we view each of these theses, which ones we find plausible and which will be our focus in this paper.

For us, a mechanistic view is one that understands the world as comprised of mechanisms, where—consistent with the consensus view—'a mechanism for a phenomenon consists of entities and activities organized in such a way that they are responsible for the phenomenon' (Illari & Williamson, 2012). This view of a mechanism traces its roots back to Descartes, not to the atomists. Such a view tends to carry with it a 'bottom up' causal structure, where smaller mechanisms upwardly cause the behaviours or actions of the things above them, implying a kind of reductionism. And here, reductionism is the idea that everything within the sciences should be reducible to a single level of causation, e.g. everything that happens in economics should, in principle, be explainable in terms of particle physics. For present purposes, we do not need either the mechanistic or the reductionist theses.

The hopes of reducing all science to fundamental physics (or whatever other area of science) seems to have been a dream of the 1960s—one that many philosophers and scientists have abandoned (see e.g. Fodor, 1974). [Sehon (2005) argues for why teleological explanations cannot reduce to causal explanations, when it comes to the reduction of the mental to the physical. While we are interested in intentional mental states, here we are concerned with reductionism in the sciences, rather than in the philosophy of mind.] Mechanism, on the other hand, has been more persistent. But we, like others in the recent biological literature (see e.g. Nicholson, 2013, 2019; Nicholson & Dupré, 2018), have reasons to think a mechanistic approach that understands natural entities as machines is deeply flawed in several important respects. In any case, we're not going to mount an argument against mechanism in biology here. Yet differentiating reductionism and mechanism from the other theses is important because we do find the theses of determinism and materialism compelling, and generally true.

It is worth noting here that in our discussion of field theory below, we do use the word mechanism, but that we do so with few ontological commitments. It is more of a placeholder. Further, in doing so, we are concerned that we may seem to be distancing ourselves from the process ontology of Nicholson & Dupré, 2018, Meincke 2019, and others. In fact, however, we find those views to be persuasive, and we have chosen to use the term 'mechanism' rather than 'process' only to avoid unnecessary confusion for those not familiar with process ontology.

Materialism (or physicalism) is simply the thesis that whatever exists supervenes on, or is grounded in, the physical. The idea of materialism is nothing new, as seen in our very brief survey of the ancients. It stands in opposition to dualism of various stripes. Materialism is widely accepted throughout the sciences and is generally thought to be true due to problems faced by dualists.

Then there is determinism, its relationship to the other 'isms', and the possibility of domains in the world wherein determinism doesn't hold. While there are various ways of framing determinism that often depend on how one understands the laws of nature (see e.g., Maudlin [2007] for an interesting view of the laws of nature), in this paper we're going to ignore those details and take determinism to be the general thesis that past events are what determine future events in accordance with the laws of nature, where 'events' are understood as physical phenomena. As we've already stated our position on materialism, it follows that both past and present events are wholly material in our view.

Throughout this paper we will treat determinism as true, while remaining agnostic about its actual truth. There are several reasons we take this position. First, there are many domains within the physical sciences that pose serious challenges to the deterministic thesis. These don't prove deeply problematic for us because most of these domains are primarily in quantum mechanics and we have little to say about how teleology might function at the quantum level. And even in the cases where there could be indeterministic features of the world that exist at more macro levels (see e.g. Brandon & Carson, 1996; Nicholson, 2019), accepting such possibilities isn't particularly detrimental to the argument of this paper for reasons that we'll address in later sections. Second, and perhaps more importantly, we treat determinism as true because it often seems to be a background assumption in many of the sciences, particularly among folk perceptions of the sciences. Why this is the case is bound up with the conceptual confusion that's often present in trying to disentangle materialism from determinism. There tends to be slippage from the premise that 'everything is physical' to the further premise that 'everything is determined'. When materialism is equated with determinism, regardless of whether or not particular theories within a specific area of science actually entail determinism, to many the fact that they are materialistic implies they're deterministic as well. The Epicureans were guilty of this when taking onboard the atomists' thesis, and it seems many today are prone to the same kind of slippage. Given this, one might imagine that our task here is to disentangle materialism and determinism, so that we can accept the former, reject the latter and clear the way for teleology. But our mission here is different. It is to show that for teleology and freedom, the slippage is not a problem, because both are perfectly compatible with a deterministic world (whether or not every corner of the world is, in fact, deterministic). We want to show that the possibility of a deterministic world turns out to be a paper tiger. It doesn't threaten the existence of purpose, teleology or freedom.

MAYR, MECHANISM AND DETERMINISM

As we said, our position on mechanism will not figure much in our discussion here. But the perception that mechanism and teleology are at odds extends far beyond antiquity. It also figured prominently in early 20th-century analyses of teleology (e.g. Guthrie, 1924; Harris, 1959). But the relationship between determinism and mechanism deserves special attention, because it was central—albeit implicitly—in one of the pre-eminent treatments of teleology in modern times. We are referring to Ernst Mayr's work, in which—we argue—he uses the notion of mechanism to attempt a kind of end-run around the problem that determinism seems to pose for teleology. Our view, of course, is that this move was unnecessary, because determinism in fact poses no threat. But Mayr's work is so well regarded and often cited that it is worth thinking about what the move was and why it fails.

When Mayr discusses 'seeming or genuinely goal-directed processes' (Mayr, 1988: p. 3–4), he takes them to be mechanistic. He introduces a distinction between two kinds of teleological processes. Teleomatic processes are those that are goal-directed and follow the laws of nature, whereas teleonomic processes are goal-directed and are controlled by a 'built-in program'. A rock teleomatically falls downward until it is stopped by an external impediment, or a heated piece of iron cools when the heat is removed (Mayr, 1988). (It is worth noting that Mayr's usage of teleonomy is somewhat different from Pitterndrigh [1958] and others in this issue. See our Afterword.) In contrast, examples of teleonomy are the goal-directed behaviours and ontogenetic development seen in organisms. They also include goal-directed activities that have been 'programmed' into machines, i.e. early computers and cybernetic systems. For Mayr, DNA is held up as *the* program in living nature. And both kinds of goal-directed processes are mechanistic in Mayr's view. Unfortunately, Mayr does not explain what he means by 'mechanistic' anywhere in his treatment of teleology. And given subsequent discussions on the different ways mechanism can be understood (see Nicholson, 2013), the work that Mayr's talk of mechanisms is doing is not entirely clear.

But it is easy to imagine what might be going on. Mayr appears to accept the dichotomous line of thought that we have inherited from the ancients, and that is also seen as a problem by philosophers during the first half of the 20th century. On one side of the equation there is scientific rigour that appears to imply materialism, determinism, mechanism and reductionism, all of which modern science takes to be devoid of purpose and teleology. On the other side is a world full of purpose, teleology and final causes. And his talk of mechanisms sends the message that he is squarely on the side of modern science. Then, he tries to thread the needle, to slip goal-directedness through his vision of a mechanistic world by arguing that the teleonomic processes we see in nature can be accounted for if we can only understand the way nature's program operates. Another way to say this is that Mayr is declaring his allegiance to the whole 'isms' package, while at the same time trying to create some wiggle room between the determinism part of the package and the mechanism part. In this interpretation, his talk of mechanism is a shorthand way of indicating he accepts the full package, with no spooky teleology allowed. Consistent with this, he takes some trouble to distance himself from the metaphysically suspect teleology of Aristotle. And at the same time, his use of the word mechanism without explication leaves room for some freedom—some non-determinism—somewhere in those complex genetic mechanisms, and in the complex evolutionary process that produced them, a process he was aware contained some stochastic elements, especially mutation and drift.

In fact, Mayr's move was unnecessary. Mechanisms seem deterministic because it's difficult to imagine how the past arrangement of mechanisms doesn't determine their future states given their causal structure. Yet, mechanism doesn't necessarily entail determinism, as Bogen (2005) has argued, because it seems possible for mechanisms to be stochastic. Thus, one might adhere to a mechanistic view without holding the deterministic thesis. Similarly, the thesis of determinism doesn't commit one to a mechanistic view either. Determinism, as we've stated it, has nothing to say about mechanisms and so one could easily imagine a non-mechanistic, yet deterministic world. Therefore, neither determinism nor mechanism entail the other. Nevertheless, when Mayr was writing it did generally seem as though determinism was tacitly implied when invoking mechanism. So Mayr gets to tacitly invoke determinism, through his use of the word 'mechanism', while at the same time allowing some indeterminism, just enough to support the freedom necessary for teleology. But of course, examined in the light of day, it's clear this move doesn't work. If mechanism did entail determinism, and if you think determinism is a problem for teleology, then you've still got a problem. Because in that case mechanism doesn't create any space for freedom.

More generally, trying to make room for teleology this way is futile, like looking for a loophole in natural law. Tax laws have loopholes but the law of gravity does not. The strategy seems to be to accept all of the scientific 'isms' and then try to find some corner of the universe where they don't fully apply, some corner that isn't determined, some corner for the free, autonomous action that Aristotle observed and that is so obviously present in all teleological systems. The strategy is reminiscent of the Epicureans' search for nature's swerve, that can, somehow, make room for the possibility of free will.

In this paper, we adopt a different strategy. We begin by restricting ourselves to two of the four 'isms', materialism and determinism, and then showing, using a body of literature from philosophy, that there's no reason teleology can't fit within such a world. To do this, we begin by discussing the crucial role that freedom plays in goal-directed systems. Then we turn to an account of goal-directedness called field theory and argue that it fully accommodates all of the freedom that teleology requires.

FIELD THEORY

Freedom is an essential component of a teleological system (see McShea, 2012, 2016; Babcock & McShea, 2021). Many of the treatments of teleology in the past century have ignored the freedom issue (e.g. Wright, 1976; Nagel, 1979; Mayr, 1988), but it is hard to see how a deep understanding of teleology is possible without addressing it. Here we take on freedom directly. In particular we adopt the view of freedom laid out in McShea (2012, 2016): freedom is determination by local causes, by the entity's unique properties and the unique local environment in which it finds itself. But to see why freedom is important in understanding teleological explanations we need to discuss the broader theory of teleology that was put forward in these papers. Most recently we've dubbed this *field theory* (Babcock & McShea, 2021).

Field theory provides an account of teleological systems by combining theories on the physical properties of hierarchical structures (see Campbell, 1958; Simon, 1962; Wimsatt, 1974, 1994; Salthe, 1985, 2009) with the notions of persistence and plasticity developed in Sommerhoff's (1950) and Nagel's (1979) treatment of teleology. As the name suggests, field theory posits a hierarchically structured series of fields that provide 'upper direction' to the goal-directed entities that are nested within them. Entities within a field are guided or directed by the physical properties of the field, in such a way that they exhibit the hallmarks of teleological behaviour, persistence and plasticity, which we'll explicate shortly.

Goal directedness refers to a huge range of different kinds of systems, from simple organismal tropisms (e.g., a snail climbing up a beach) to complex physiological and developmental systems (e.g., hormonal regulation and an acorn developing into an oak tree) to human intentionality. In this section, to explain field theory we stick to the relatively straightforward cases like the first two, saving the third for the next section, where we develop our notion of freedom.

The theoretical framework of field theory can be summarized with four principles:

1. Fields. Following Levin (2012), a field is a physical structure that is non-local, and that influences smaller entities contained at any point within it. For us, as for Levin, fields are strictly physical, but the notion is applied permissively here in that we understand them to be realizable in a wide variety of different physical mediums. A chemical gradient created by diffusion of a nutrient in water is a field, as is the sound field generated by an orchestra playing a piece of baroque music, or the gravitational field around a large body. Fields must be large but need not exist continuously, at all points in space. So an advertising campaign, with ads visible only to those with access to the right media, is a field.

So broad is this notion of fields, so encompassing of very disparate sorts of physical structures—from the chemical field to the 'advertising field' referred to just above—that it will easy to imagine we intend the term to be understood as a metaphor or a heuristic of some kind. We do not. In our conceptual scheme, all fields are physical. The advertising field is complex, including many different kinds of objects—from billboards (perhaps) to online infomercials—but it is clearly physical, extended in space and time and having measurable causal effects on the physical goal-directed entities (customers) within it. A field may not exist as a solid, continuous physical object (as a gravitational field does not), but there is a physical unity to it, detectable in the consistent way it interacts with the goal-directed entities inside it that it guides. We treat fields more formally elsewhere (Babcock and McShea, in preparation).

2. Upper direction. What is common to all of these physical structures, and what makes them fields, is the second principle of field theory, upper direction. A field directs the entities within its spatial boundaries and does so from above. Thus the chemical field generated by a nutrient diffusing in a pond directs a bacterium up the chemical gradient. The sound waves emitted from the instruments in a symphony have the effect of, say, lifting the spirits of the people listening. [It also reduces their blood pressure (see e.g. Chafin *et al.*, 2004).] And the gravitational pull of a large body directs smaller bodies towards its centre. Upper direction stands in contradistinction to lateral direction, which refers to local interactions between similar sized entities. When one bacterium climbing the nutrient gradient bumps into another, knocking it off course, that is lateral direction. One billiard ball knocking into another, changing each ball's trajectory is lateral direction. The bump is a source of direction in the sense that the impact of the first ball directs the movement of the bumped ball. If I ask the person across from me at dinner to pass the stuffing, and they do, that is lateral direction. In all cases, the interaction is causal and involves entities of about the same scale. In contrast, the gravitational field within which all the billiard balls are contained provides upper direction, directing any ball that finds itself in the empty space over a pocket down into the pocket. The field is large, far bigger than the billiard balls it is directing.

3. Persistence and plasticity. Borrowed from Sommerhoff (1950) and Nagel (1979), these terms

describe the behaviour of teleological entities. Plasticity is the tendency for a teleological entity to orient itself toward its goal from any starting point within the field. A bacterium adopts a trajectory toward higher concentration in the food field from any starting point in the field. That is plasticity. Persistence is the tendency for the entity to return to a trajectory toward the goal following perturbations, such as those arising from lateral interactions. So if the bacterium in the food field is momentarily blocked by a particle of sand, and if this lateral bump does not reorient it to a trajectory that takes it out of the food field, then it returns to a trajectory toward higher concentration. In all cases, it is the field that makes persistence and plasticity possible. It is the fact that the field is present over a large area that enables it to guide the goal-directed entity from any starting point in that area, and to restore its trajectory over a large range of possible perturbations. [Importantly, unlike Sommerhoff and Nagel, we are not using persistence and plasticity to define goal directedness. For us, these are merely signature behaviours of goal-directed entities.]

4. External direction. The fourth principle is that direction of the goal-directed entity is always external. That is, it arises from the field, which is spatially larger than and envelopes the goal-directed entity. The external chemical field is what orients the bacterium. The temptation might be to think that the bacterium itself—the complex molecular mechanism inside it—is responsible for its goal-directed behaviour. But that is a mistake. Without the field—without the chemical gradient—the bacterium is blind, directionless. Of course, the bacterium must have the right internal mechanisms to detect the field, propel itself with a flagellum, and so forth, but it is its external field that tells it where to go, that tells the organism where the nutrient concentration is greater and where it is less. Nothing within the bacterium, none of its internal mechanisms, contain any information about the nutrient concentration that could orient it up the gradient. The internal mechanisms are crucial, but the *guidance* in goal-directed systems is external. [Of course, external is a relative term. The bacterium has 'external' fields within it that guide even smaller mechanisms inside the organism, creating a hierarchy of goal directed systems within goal directed systems.]

So far we have not mentioned freedom, the key ingredient that is missing from Mayr's account. As will become clear shortly, teleological entities are not governed only by the fields that direct them toward the goal. There are three other sources of directional influence in goal-directed systems. In field theory, these three are the source of freedom.

THREE TYPES OF FREEDOM

A goal-directed entity that is *perfectly* directed by a field is not free. A homing torpedo that is guided by the sound field coming off a target ship and propels itself in a straight line toward the ship without deviating is not free. The field tells the torpedo what to do, so to speak, and the torpedo that makes a beeline for the ship is doing it. An entity that does *exactly* what it is told is not free. Freedom is doing something else.

The first kind of freedom comes from lateral direction. If a bacterium in a food field bumps into a tiny sand grain, the grain can reorient it, sending the bacterium in the opposite direction, toward a lower concentration of nutrient. The impact is a lateral one, delivered by an entity of about the same scale as the original bacterium. There are many such lateral forces in nature, which means that teleological entities seldom take the shortest possible route to their ends. Typically they are repeatedly knocked off course by perturbations, and if the perturbation is not too disruptive, they correct themselves, returning to a field-directed path. In other words, they persist. Depending on the entity and the field, the kinds of lateral direction vary greatly. A homing torpedo that snags momentarily on a piece of kelp is laterally directed by the kelp. A buried acorn that sprouts and grows upward but is blocked by a small rock above it is laterally directed by the rock. If I head for the fridge in search of a snack but am distracted by the tone of an incoming text message, that is lateral direction (although as will be seen shortly, this example is somewhat more complicated than the others).

All of these lateral interactions produce deviations from the path directed by some specific upper-level field. Such deviations are common, and they constitute a kind of freedom in that they represent movements that are independent of the upper-level field. We call this type of freedom 'lateral freedom'. Of course, lateral freedom does not line up well with standard notions of freedom. A person riding a bus has their forward movement directed by the bus, but in our conceptual scheme, if they are bumped by another rider who has lost their balance, the path deflection caused by the bump counts as lateral freedom. Now obviously the person who was bumped did not 'freely' choose to move. But in field theory, such a bump would be considered free. It is movement that is independent of, free from, the directionality imposed by a specified field, in this case, the bus. 'Freedom' in our conceptual world is freedom from the field, or movement that is independent of the field.

The second type of freedom arises when upper-level fields overlap. We call it field-overlap freedom. Imagine a beachball floating in a middle of a large river. As the river flows, the ball moves downstream directed by the water in the river. In this toy example, the river is a field in which the ball is (partly) immersed, carrying the ball downstream. Now let's overlay another field. Imagine a wind picks up, blowing the ball against the current. The river and the wind are both upper-level fields. Both are physical, at least partly envelop the ball, and are larger than it. When fields overlap in such ways, an entity is 'free' from one field insofar as it is directed by the other field. When the ball is blown upstream, against the current of the river, it is to some extent free from the river field. The homing torpedo that is momentarily carried off course by an ocean current is in the same situation. The current is a field, one that at that moment overlaps the sound field from the target ship, and the torpedo's deviation from a path toward the target ship is an instance of freedom from the sound field. [As we will see, decision making in thinking organisms involves overlapping fields, affective fields, acting downwardly on cognitive and motor centres. Choices are the outcomes of multiple overlapping affective fields, each directing thought and action toward somewhat different ends.]

Thus, in field theory, overlapping fields produce a kind of freedom, that is, *freedom from some specified upper-level field*. Like lateral freedom, this kind of freedom does not comport with conventional usage of the word. It will sound less odd when we get to the third kind of freedom. For now, let us just say that our usage understands freedom in a relative sense. The wind-blown ball is (partly) free with respect to the river, just as a felon freed from prison may be said to be free with respect to prison (in the sense Hume suggests in the *Treatise*). Of course, saying the felon is free is never meant to imply freedom in any absolute sense. Once released from prison, there will be any number of constraints still at work limiting a felon's choices and movements, just as there are for all of us. But in a relative sense, with respect to one particular set of constraints, prison, this person is now clearly free. Likewise, freedom is used here in a relative sense to describe movements caused by forces that are independent of some specific field. Our use of 'freedom', particularly in these first two senses, admittedly does not align with the way freedom is often treated in the philosophy of action and in other areas of metaphysics. However, this is, in part, our aim—to suggest there are other types of freedom that are generally overlooked.

The third type of freedom aligns more closely with conventional usage. It is the freedom that is exhibited when an entity moves independently of some particular field, not on account of some lateral interaction or an overlapping field, but because there's a field operating entirely *within* the entity itself. Consider the bacterium again. In fact, real bacteria do not swim directly up a gradient. Instead they make a series of straight runs, followed by tumbles that reorient them randomly. On-average movement up the gradient is achieved only because the cell's internal mechanisms detect the gradient and lengthen the straight runs when it happens to take the organism in the right direction. In our terms, the lengthening of the straight run is not free. That is determined by the field. What is free is the choice of direction of the straight runs, as well as the tumbling. These are field independent. And they are type-three freedom in that their causes lie inside the organism, in the molecular mechanisms governing the flagellum, rather than in any lateral bumps or overlapping fields originating outside it.

Let us consider a more complex case, one that reveals the strong connection with conventional views of freedom. If a demand is made on me, I am free in that I could choose to do something else. If my employer demands that all employees work harder, then the fact that I could make a choice that is independent of that demand—I could continue in my usual slothful work routine—means I am free with respect to it. If an ad urges me to 'Buy now, before the sale ends!' and I make my buying decision for other reasons—whether deciding not to buy at all or deciding to buy but for reasons unrelated to the sale—I am free with respect to the ad's urging. The demands of my employer and of the ad can be understood as external fields acting on my psyche, and thus my thoughts and behaviour independent of those fields constitute my freedom with respect to them.

The bacterium's straight-run-and-tumble process and a person's ability to act independently of external demands could not be more different at the level of materials and mechanism. What they share though is freedom in the type-three sense. Internal mechanisms of some kind cause them to behave in ways that are independent of an external field. In other words, they are free on account of some degree of autonomy, on account of their ability to generate behaviour from within. This third kind of freedom we call 'autonomous freedom'. Contrast this with the lateral freedom of the person bumped on the bus, who is free in the sense that the forward urging of the bus is momentarily overcome by the impact of the other rider. Or with the field-overlap freedom of the beachball, which is free in the sense that the trajectory urged by the water is overcome by the wind. For the bacterium and for the person, the source of freedom is internal.

AUTONOMOUS ENTITIES AND AUTONOMOUS FREEDOM

Here we introduce the notion of *autonomous goal-directed entities*, entities for which some of their goal-directed behaviours arise from hierarchically nested structures inside them. But right at the outset, we need to acknowledge that this concept will seem to place us in a troublesome contradiction. On the one hand, we have claimed that in goal-directed systems, direction is always external. On the other, we have described autonomous freedom as behaviour in which the behaviour originates within the entity, in which external factors do not direct. But in fact there is no contradiction, because of the way that an autonomous entity is structured. It has fields that are internal to it, fields that act downwardly on its parts but that produce whole-entity effects, and that do so without guidance from fields external to the whole entity.

Hormonal regulatory systems offer good examples. Thyroid hormones circulating throughout the organism constitute a large-scale, organism-wide field. Receptors for these hormones are present on a wide variety of contained tissues: brain, heart, liver, muscles and other organs. The hormone field acts downwardly on each of them, causing a regulatory response. And the net effect is global: changes in organism-wide metabolic rate and growth. In other words, the field is large, the target organs are contained within it, and they are upper directed, but there are consequences for the entire organism.

Extending the example, the thyroid itself is upper directed by a hormonal field generated by the hypothalamus, and in turn generates a field that directs the hypothalamus, creating an internal feedback loop. The whole system is goal-directed in that it persistently and plastically maintains a stable steady state, or a stable trajectory in the case of growth. And it is autonomous in that it operates without external input. Which is not to say factors external to the organism have no effect. They do, but even so the overall picture is of a system that governs outcomes at the scale of the whole organism and that runs itself.

The oestrous cycle is another example. As are circadian rhythms, which are regulated by a field external to the organism, sunlight, but in the short run can self-maintain in its absence. Elsewhere we have raised the possibility that intentionality involves neural fields that are larger than cognitive and motor centres and regulate them from above (Babcock & McShea, 2021). Getting up and walking around the house could be a largely autonomous process, a motor response to a generalized antsy feeling in the motivational areas of the brain, a process set in motion not by some external event but originating internally, following a long period of sedentariness.

This viewpoint invites us to see organisms as multilevel field structures, a nested series in which one field is immersed within another field, which is immersed in another, and so on. This nesting extends far below the scale discussed in the examples above. A kidney is regulated from above by various hormones in the circulatory system, and in turn regulates its own cells within it, and those cells in turn have membranes that regulate the flow of molecules into and out of themselves. There is a tendency in contemporary thinking in biology to think of regulation as originating deep inside, at the molecular level, with genes as the regulators. We think, and have argued elsewhere, that this is a mistake, that in fact it is gene-expression gradients, and morphogenetic fields, that do the regulating [see Babcock & McShea (2021) for further discussion].

As the examples above illustrate, hierarchically nested systems are capable of some fairly complex goal-directed behaviour. And some of their behaviour is autonomous because, even though the causal arrow runs downward from a large-scale field to smaller contained entities, all of this takes place mostly or entirely inside the entity's outer boundary. To the degree they operate like this, these systems are free. Their behaviour is organized, directed, by fields inside them, and is to a large extent independent of fields outside them (Fig. 1). And causal independence is freedom.

The nested hierarchical structure we have described looks to be the sort that requires substantial engineering, by millions of years of natural selection. On the other hand, some degree of autonomous freedom likely occurs in purely physical systems. The formation of the eye wall in a hurricane looks autonomous, with the flow of warm air through the structure as a whole generating an internal structure that is smaller than the whole but affecting the large-scale structure of the whole. Still, our suspicion is that the most compelling cases of autonomous freedom are going to occur in organisms or—as will be seen shortly—heavily engineered artifacts.

MECHANISM, CONTROL AND DETERMINISM

Before proceeding to talk about freedom and determinism, an aside is worthwhile here on two notions that hover over the discussion. First, mechanism. As discussed earlier, mechanism and determinism have been closely linked in conventional thinking on this subject. This is unjustified, in our view, and field theory explains why. Consider an understanding of a 'mechanism' as consisting of the objects and interactions inside a higher-level structure, a field, that at least partly explains an entity's behaviour. In a multilevel hierarchical structure, like a thyroid regulatory system, the objects and interactions at a given level are both a mechanism to the field above it, and a field to the mechanism below them. The thyroid generates a hormone field in which the hypothalamus acts as a mechanism. And the hypothalamus generates

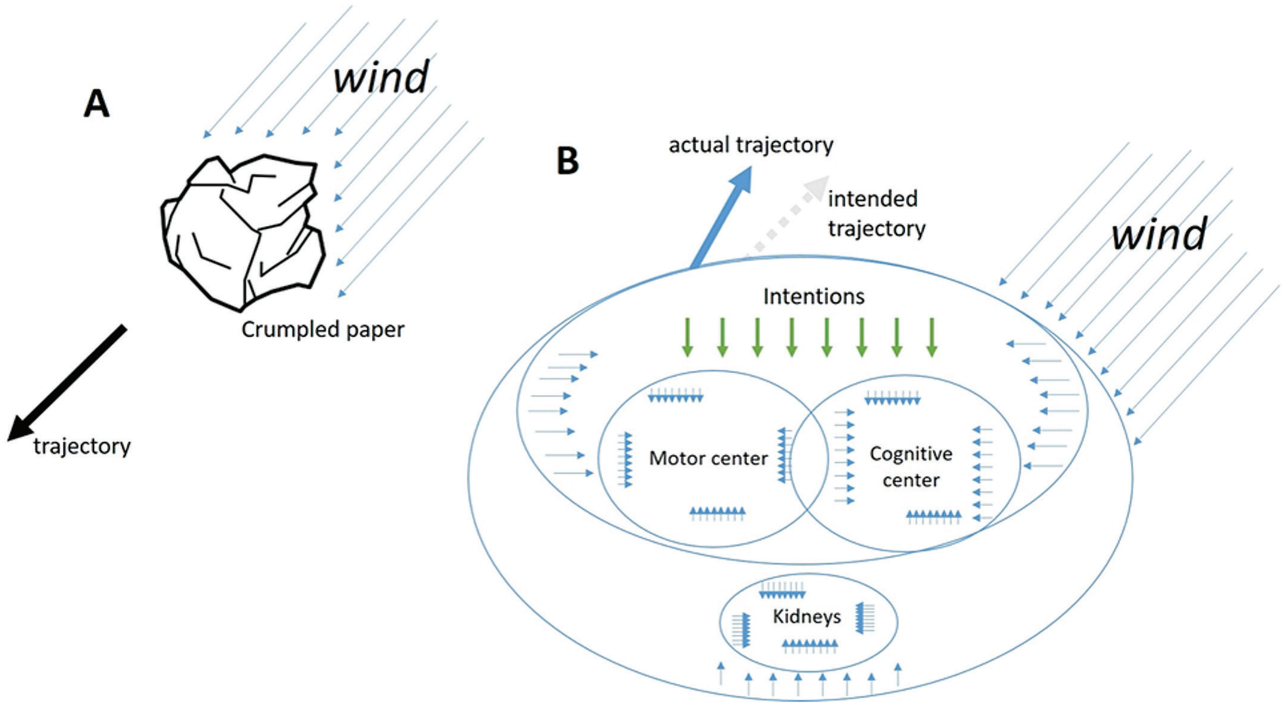

Figure 1. A, a simple entity is directed by an external field. It does what the field directs (with minor deviations due to perturbations). Here, a piece of crumpled paper is blown by the wind. The piece of paper has very little autonomy, agency. B, an entity with multiple levels of entities within fields. The external field directs it, but the direction that an internal field delivers to contained entities (long vertical arrows) causes it to do something dramatically different. Here, an organism's intention acts on the cognitive and motor centres causing it to move upwind, with some minor deflection caused by the wind. The organism has considerable autonomy, agency.

a field in which the thyroid acts as a mechanism. Thus, one thing can be both the source of a larger field that regulates something and a mechanism in a larger field generated elsewhere. We discuss all this for two reasons. One is to show the sense in which the conceptual scheme we are advancing is thoroughly mechanistic. It recognizes all entities as having internal mechanisms of various kinds, leaving room for no non-mechanistic aspects. The other is to show that mechanism understood in this hierarchical way is consistent with freedom. An independent entity is free when its various hierarchically stacked internal mechanisms cause behaviour that departs from the demands of the field above it.

Now consider the notion of control. Above we have shown how goal-directed entities can deviate from the direction imposed by upper-level fields, with autonomous entities having some influence over their own destiny and entities with little internal structure achieving freedom as a result of lateral or overlapping field-induced bumps. In both cases, deviation reflects the fact that in teleological processes, fields are not all encompassing in the way seen in other kinds of causal explanations, like the law-based explanations so often arising in the physical sciences. Upper-level fields are not so overpowering that they fully control the entities within them. In fact, they often possess very little control over teleological entities while still partly determining them. And here it is important to distinguish between *control* and *determination*—an insight we thank Dennett (1984a, 2017) for. It is the absence of control by the field, and the partial independence that teleological entities have from the field, which tends to lead to the common belief that they simply cannot be deterministic. But this conflates determinism with control. Determined things are not necessarily controlled. There are countless examples that demonstrate as much. The interaction between the sun and a sunflower is deterministic, directing the sunflower to face the sun as it moves across the sky, but the sun does not control the plant. A passing animal can momentarily deflect the plant in any direction at all. The interaction between an individual's brain and the ads promoting the prevailing mortgage interest rate is deterministic, but the ads do not control the brain. They do not dictate that anyone will buy a house. Fields tend to work in this way. While a field is what provides the direction to a goal-directed entity, the locus of causation that make it behave persistently and plastically, the field does not exhibit anything akin to control. To think otherwise is to conflate and anthropomorphize passive, law-like determinism with the kind of control that is common to certain kinds of human intentionality. The entity remains uncontrolled, free, as demonstrated by the fact that it can be knocked off course by all sorts of lateral perturbations.

FREE AND DETERMINED AT THE SAME TIME

Now we are in a position to return to our original question. How does this observation about the structure of autonomous entities help solve the apparent tension among teleology, freedom and determinism? In other words, how does field theory show that teleological entities can be simultaneously free and determined?

Consider a simple multilevel, autonomous entity, like a self-driving car. The recent technological advances made in self-driving vehicles provide an excellent, non-biological example of autonomous freedom. One can program a self-driving car to begin at its current location and arrive at another provided by a GPS waypoint or destination. The GPS guidance provided to the car is comprised of a series of networking satellites bouncing cellular signals. This is an upper-level field, external to the car, that guides it to its destination. Insofar as someone chooses the destination for the car, the car has little freedom with respect to that destination. And as the network guides, it has little freedom with respect to the route. Yet, during the actual trip, sensors contained within the car actively detect obstacles in its path, telling the car to veer right or left, to avoid this pothole or that pedestrian. At this level in the hierarchy, the car possesses some degree of autonomous freedom, that is, freedom with respect to the GPS field. This is autonomous freedom in that it arises from some combination of small fields and their internal mechanisms, all located entirely within the car: the braking system directing the brake calipers, the steering system directing the steering linkage, etc. And these systems are contained within the larger computational system that directs the local, moment-to-moment movements of the car. What we are proposing here parallels the arguments presented in List (2014, 2019) on free will, where List shows, using the principles of multiply realizability and supervenience, that there are physical states and what he calls 'agential states'. For List, what happens at the level of physical states is completely determined, while at the higher level agential state there is genuine choice. For us, this translates into being able to say that at a higher level of organization, where there is goal-directedness, there is at the same time, at a lower level of organization, complete determinism. This sort of multi-levelled approach to understanding agency is close to what we're suggesting.

Notice that there is no 'ghost in the machine'. Everything about a self-driving car's onboard sensors and controls on braking and steering are deterministically governed. The level-specific 'choices' the car makes about how to avoid potholes come from algorithms designed by engineers that synthesize inputs from the external environment alongside information about the car's performance capacities to arrive at the optimal path. While this process is complex, it is determined in that each decision the car makes has a deterministic causal explanation. And at the same time, the moment-to-moment operation of the entire local response system could be entirely independent of the GPS guidance system that chooses and executes the overall route. Local guidance is autonomously free and yet determined, at the same time, again in a way not unlike List's proposal.

Perspective is critical in making sense of these hierarchically deep nested systems. Freedom at one level looks like noise from a perspective one level up. From the perspective of the GPS system directing the car to its destination, the various swerves and speed changes to avoid potholes and pedestrians look like random deviations, like noise. The car seems to be doing bizarre things unrelated to the overall goal of getting to the destination. But from the perspective of the car, these swerves and speed changes make sense, and constitute intelligent self-directed behaviour. The entire process is deterministic, but from this lower-level perspective it looks free, that is, free from the larger demands of the GPS field.

Of course, one might object that a self-driving car conforms to Mayr's notion of teleonomy. The car is guided by a computer 'program' at the local level. But notice that the theoretical framework we've used to describe the system above doesn't require any reference to cybernetics (or any type of program) to explicate the way the teleological system operates. All that is required is a hierarchical structure of fields and mechanisms. Also, Mayr's notion of program makes no reference to any hierarchical organization. And hierarchy lies at the heart of teleology and freedom. Without it, there is no teleology and there is no freedom.

Once this hierarchical structure of mechanisms within fields is clear, the ubiquity of such systems becomes clear. It extends not just to human-made artifacts but to all of biology as well. A tick questing for a host on the end of a blade of grass is directed by upper-level fields. Its Haller's organs, which are unique sensory structures on a tick's front legs, detect carbon dioxide and ammonia emitted by its prey. In combination with the movement it detects from a passing animal, the carbon dioxide and ammonia are the upper-level field within which a tick is immersed and that is what directs it. Once the tick grabs onto the leg of some (unfortunate) animal, it's then directed by the butyric acid and heat signatures the animal emits. These are the next upper-level fields that direct the tick to the point where it will embed itself. And while butyric acid and temperature are the next fields to direct it, the tick is presented with various 'choices' along the way. Should it crawl to the neck or to the belly of its prey? When presented with such a choice, the butyric acid and temperature fields might simply present equal directional pull towards the neck and towards the belly. Thus, like Buridan's ass, the tick faces a choice where the external direction of the field wanes. Only, unlike the ass, the tick does not remain frozen in place, it simply crawls in one direction or the other. Two ticks similarly positioned on a large animal might choose differently. From the higher level there is a sort of gap where the directional force of the upper-level fields hold less sway. At such gaps, the tick has autonomous freedom and what we might call choice. It acts autonomously because at a lower level in the hierarchy, the fields that are internal to the tick take over. And so, it opts for the neck. Notice that everything the tick does is still governed by some field. At the moment of choice, the fields external to the whole tick have fallen away, and the only remaining field is the one in the animal's brain and neural system that governs its motor mechanisms. This field is internal to the tick, to be sure, but still external to the motor mechanism it guides. When choosing between the neck and the belly, a goal-directed system within the tick *determines* that it will elect the neck over the belly. Like the self-driving car, all that has changed is which field within the hierarchy becomes the point of focus. Notice the perspective dependence as we scale up and down the hierarchy. Viewed from a higher level, the tick's choice is free and independent. Viewed from a lower level, deterministic processes govern. One and the same process can be simultaneously free and determined, without contradiction.

The more complex systems we encounter in human decision making have precisely the same kind of hierarchical structure. Consider the person deciding whether to heed the ad encouraging them to 'Buy now!'. From the perspective of the larger system—the company, the advertising campaign, the retail outlets, etc.—the behaviour of individuals looks noisy. Some individuals seem to ignore the ads. Some go to the retail outlet but do not buy anything, and so on. But from a perspective lower in the hierarchy, that of the individual, the behaviour looks free and self-directed. I went to the store, saw that the product did not suit my needs, and decided not to buy. My behaviour could be dictated by thoroughly deterministic internal mechanisms, but with respect to the ad, 'Buy now!', it is free. Thus, for these hierarchically deep nested systems, for autonomous entities, whether a given behaviour looks free is a function of where in our imaginations we choose to draw the boundaries, how we demarcate the system of interest. Again, at a higher level, when we look down we see freedom and independence, while at a lower level we see deterministic processes.

This last example was an easy case, because the two levels of interest—the company with a product to sell and the individual's conscious decision-making—are relatively well understood. We can directly observe the first, and we have introspective access to much of the second. At the next level down the hierarchy, where we encounter the neural processes that underlie decision making, the causal structure is poorly known, and it is hard to make a strong case that the structure of the system is hierarchical in the right way. Still, under the protective shell of speculation, we can venture somewhat tentatively into that territory. Affective processes—wants and preferences—direct thinking, in humans and many other organisms. I want dessert, and this want directs my thinking toward devising ways to get it. We do not know for certain that the system is arranged hierarchically, with cognitive and motor processes physically nested within affective fields, but nothing that is known in neurobiology contradicts this, so let us suppose that they are. In that case, let further suppose that processes at both levels are completely deterministic for, again, there is little reason to think physical brains are mysteriously exempt from the determinism we find throughout the rest of the physical world. I have just had dinner, and my habit of eating dessert after a meal, along with my love of sweet things and the fact that dinner was not very filling, all but completely determine, let us say, the fact that I will crave dessert right now. And let us also say that the neural processes that constitute thinking—the computational processes involved in recalling a mental list of dessert alternatives, assessing their availability, and devising ways to get the preferred ones—are also deterministic. Now, consistent with how we have argued above, we can say that those cognitive processes are free to the extent that they are independent of my desire for dessert. And indeed, that is how it looks to us from above, at higher levels of awareness. Cognition looks at least somewhat free. The mental assessment of the prospect of getting cheesecake tonight takes a momentary strange turn as my mind wanders to the last dinner party at which I had cheesecake. In thinking about the possibility of having lemon meringue pie, I find myself thinking about how long it takes to beat the egg whites to make meringue. The entire train of cognition is loosely directed by my present higher-level desire for dessert. And from that perspective, the lower-level cognitive processes they are directing look like noise, like free and uncontrolled diversions—albeit necessary ones—from the overall mission of getting some dessert. But from the perspective of the lower level, the neuronal processes governing the trajectory of cognition, those process could nevertheless be completely deterministic. As in the above examples, lower-level processes are free to the extent that they follow their own deterministic trajectory, independent of upper-level fields.

COMPETING INTUITIONS

Entities with very little internal structure tend to have a negligible amount of autonomous freedom. Yet, some such entities can remain teleological because of the types of freedom they do possess. A ball that rolls downward in a funnel behaves both with persistence and plasticity. No matter where it starts in the funnel, nor how it might be knocked off its path, the ball will arrive at the bottom of the funnel—it is to some degree teleological. Yet, the ball's trajectory is highly deterministic, tempting us to say that it also lacks freedom, and therefore that it can't be teleological. But in our scheme, a ball in a funnel might have a high degree of lateral freedom. Imperfections in the surface of the funnel are lateral impingements that deflect its trajectory from time to time. Thus while it might be true that a ball in a funnel has no autonomous freedom, lacking any internal hierarchical structure to direct it against the pull of gravity, it has plenty of lateral freedom. Of course, if we change the setup, placing the ball in a tube with a very slightly larger diameter, instead of a funnel, its lateral freedom would be restricted. In this case, it approaches the point of having no capacity for deviation and it ceases to be teleological.

From one perspective, our scheme creates some cognitive dissonance. Somewhat counterintuitively, it allows a simple hierarchically structured system like a ball in a funnel—an entity moving within and guided by a gravitational field—to qualify for the august status of teleological. [Although if one can put aside the simplicity and familiarity of the setup, the ball's relentless pursuit of the bottom of the funnel really does seem a bit mysterious, even teleological.] On the other hand, the scheme accommodates an intuition that standard thinking does not, namely that the ball in the funnel has at least a modicum of goal directedness, at least a quasi-teleology that more rigid systems with entirely lateral causation lack, like the ball in the tight-fitting tube. The same goes for freedom. The ball in the funnel has nowhere near the freedom that an autonomous organism has. But it can move at least to some degree independently of the gravitational field that directs it, which in our scheme gives it a certain amount of freedom of a different sort, lateral freedom.

Finally, notice that the hierarchical structure of teleological systems that lies at the core of field theory is crucial in this reasoning. In a non-hierarchical system in which all causation is lateral causation, if it is also deterministic (which by assumption here, every system is), then in our terms there is no freedom, no freedom of a lower level relative to a higher one and no teleology. And in that case, the supposed conflict between teleology and determinism becomes quite real. Imagine a self-driving car with no GPS and no on-board sensors for detecting and responding to local conditions. Instead it is programmed with complete instructions for driving from any of a thousand starting points to any of a thousand endpoints. Every movement of brake and accelerator, every turn of the steering wheel, is fully programmed into it ahead of time. Or to put it in our terms, there is no upper direction, no guidance by a higher-level field of any kind. All causation is lateral. And there is no freedom in any of our three senses, because freedom is always understood as relative to some higher-level field, and by assumption, no such field is present here. Further, and not coincidentally, such a system is incapable of persistence and plasticity. If it starts somewhere other than the thousand pre-set starting points, it will not end up at its destination. If some deviation is forced upon it by local conditions—a pothole in the road jars the vehicle's path to one side—it will not correct for the deviation. Its fully deterministic programming simply has no mechanism for accommodating accidental variation. In other words, there is also no teleology. Now, we have to be careful here. Our claim is not that in systems with only lateral causation—like the hypothetical car with no GPS—teleology is impossible as a matter of logic, that it is literally inconceivable. Rather it is that as an engineering problem, it is pretty much impossible.

In sum, an appropriate hierarchical relationship is essential for both freedom and teleology. And consistent with everyday intuitions about teleology and freedom, teleology is not only compatible with freedom. Freedom is required.

A SPECTRUM OF FREEDOM

Notice that freedom, as we've conceived it with these three types, is *not* a binary concept where certain entities are free and others are not. Freedom exists on a spectrum. A ball in a funnel is fairly free laterally, while having almost no autonomous freedom. Hume's prisoner, chained to a wall, has little lateral freedom though they retain some of their autonomous freedom. They can think about whatever they like. Teleological entities present differently based on the kinds of freedom they possess and the degrees to which they possess those respective freedoms. Thus, freedom looks different in different teleological entities because it is different, and each type of freedom comes in varying degrees.

Among the three types of freedom, there's a tendency to be preoccupied with autonomous freedom. It is a special type, one that is especially relevant to timeless questions about free will and action. And there is doubtless a connection—although we don't develop it here—with another timeless issue, agency, a property not unique to humans but certainly well developed in us. The preoccupation is justified in that humans are paradigmatic multilevel entities capable of extraordinary degrees of autonomous freedom. To see just how complex this layering can be, consider Frankfurt's influential account of the hierarchy of desires, where Frankfurt famously defends a view that argues autonomous action and causal determinism are compatible with one another (see Frankfurt, 1969, 1971). Like us, Frankfurt sees a hierarchy of desires. He makes a division between first and second order desires, where second order desires are desires about first order desires. For example, one might have the desire not to desire a cheesecake. In such a case, desiring cheesecake is a first order desire and the desire not to desire is a second order desire. Notice how such a hierarchy of wants, desires or intentions easily gives rise to rich and complex systems of goal-directedness. One desire may conflict or agree with another, sometimes overlapping with some other competing wants, directing a person at one thing and then at another. Insofar as one identifies themselves with a want, desire or intention, they identify with whatever the affective state causes. And as the affective state then directs one's rational capacity, they tend to identify themselves with that direction. But, of course, the directional influence of the affective state is just as causally determined as any object that is guided by a gravitational field. It just so happens that in the case of affective states, we see them as parts of ourselves, whereas gravity is very much the other. It is this hierarchy of desires that gives rise to autonomy in a deterministic world, according to Frankfurt. We have several not entirely trivial quibbles with Frankfurt regarding how a hierarchy of desires operates, but we agree with him insofar as he shows that internal, hierarchical structures are perfectly deterministic while also being somewhat autonomous, that is, free in the colloquial sense.

At the other end of the autonomous freedom spectrum are a myriad of physical systems, like the ball in the funnel, but also a huge number of highly constrained systems in biology. Consider, for example, the pharyngeal pouches, arches and clefts that are present in tetrapod early embryonic development. Their presence is a robust phenomenon, remarkably uniform across fish, amphibians, reptiles, birds and mammals, the last three of which never fully develop the gills they are designed to support. These structures arise in development and are later removed. Thus, while vertebrate embryonic development is a teleological process, one in which tissues, cells and the genes within them are all directed by a series of upper level gene-expression domains, i.e. morphogenetic fields, all species pass through this same phenotypic stage. In the terms that have grown up around this kind of phenomenon in biology, the epigenetic landscape is highly canalized (Waddington, 1957) at that point in development, with little variation permitted. In our terms, there is little autonomous freedom.

The view that we end up with recognizes three types of freedom, with each type falling on a continuum, a function of the system and the question we ask about it. A questing tick has some autonomous freedom, but far less than the decision-making of your average human adult. A ball in a funnel has more lateral freedom of movement than Hume's chained prisoner. An astronaut who travels beyond the gravitational pull of the Earth gains more freedom from gravitational fields, while losing a significant degree of freedom upon entering the much smaller oxygen field of their ship. Examples can be multiplied endlessly. Seen this way, freedom is decoupled from determinism. It doesn't arise from escaping determinism. It's a relationship to a field and is consistent with every aspect of that relationship being fully deterministic.

It may go without saying—but for completeness we will say it anyway—the relationships among the levels in the hierarchies within multilevel entities (like people) tend to be quite complex. They are often arranged in what Wimsatt (1994) calls 'causal thickets'. A causal thicket arises in hierarchies that are 'so richly connected that neither perspectives nor levels seem to capture their organization' (Wimsatt, 1994: p. 220). We see causal thickets, not just in anatomy and physiology but often in psychology and the social sciences. In these systems, tracking down and isolating the entities and fields that give rise to autonomous freedom is no easy task. Nevertheless, this doesn't entail there is an organizational breakdown, just that hierarchical organization comes in degrees, like everything else, and hierarchical structure can be difficult to discern.

COMPATIBILISM

So far, we've aimed to show that the tension between teleology and determinism is an illusion. Teleology and freedom are perfectly compatible with causal determinism and with Mayr's mechanistic view of biological systems. To bolster this position it is important to draw attention to the rich philosophical debates on free will, as it is instructive in seeing that teleology needn't be at odds with determinism. This section shows that the view above aligns with, and is supported by, a position in the philosophical literature that's known as *compatibilism*.

Compatibilism has a rich history that can trace its origins back at least as far as Hobbes (1997) and Hume (1975, 1978), as we've already noted. More contemporary variants of compatibilist positions have been put forward by a number of prominent philosophers (see e.g. Strawson, 1962; Frankfurt, 1969; Watson, 1975; Dennett, 1984a, b; Campbell, 1997). In short, compatibilists argue that free will and determinism are, as the name would indicate, compatible with one another. Many of these more recent versions of compatibilism, beginning in the 1960s, have refined the position in response to arguments mounted by contemporary incompatibilists. [See Van Inwagen (1983) for one of the more notable statements of incompatibilism.] Very generally, compatibilists argue that if an agent is the source of what determines their actions, they are free. Being a source of determining action usually means that if facts about someone are what determine their actions, then they are the agent of those actions. Having such agency when choosing among options is precisely what we mean by 'freedom'. Therefore, as long as the thing that does the determining are facts about the agent, there is no reason to think that determinism threatens agency or the possibility of freedom. And thus, our claim that freedom and determinism fit together is built on a strong, well established foundation in philosophy. In other words, field theory aligns with the general logic of compatibilism insofar as it suggests that agency stems exclusively from facts about the organism—from structures that are internal to it—simply specifying that those internal structures consist of entities within fields.

To understand the compatibilist position, it is important to see it in the context of the freewill debate. In this context, possessing freedom or free will is generally taken to be the ability to have chosen otherwise (see Chisholm, 1964). Many have an intuition that is reflective of Mayr's implicit position regarding teleonomy: determinism and free will cannot be compatible because, if everything is causally determined, then no one is ever free to do otherwise. If facts not only about myself, but also about my ancestors, environmental circumstances, genetic makeup, etc. are what determine my actions, then I never freely choose because there's never a moment during which those causally determined facts could yield an outcome other than the one that is predetermined. This is an incompatibilist position. Mayr, like so many others, seems to have an incompatibilist intuition. He accepts the determinist position with his talk of mechanisms, but in underplaying the extent to which freedom is implicit in teleology, his aim is to skirt the tension inherent in incompatibilism. Despite the intuitive appeal of an incompatibilist position, we believe the compatibilist position is sound. However, we will not attempt to summarize the current debates between compatibilists and incompatibilists here. Instead we will note in passing that there are some contemporary views presented in the freewill debate, such as List's, that could align with, and support, with further development, much of what has been presented here (see e.g. List, 2014, 2019). Moreover, compatibilists will likely be sympathetic to our case, while libertarians and hard determinists will find our characterization of freedom not only unpersuasive, but also a nonstarter because they will likely see our taxonomy of freedom as having rejigged the concept to fit our purposes. And we could present a number of compatibilist retorts, but our aim is not to try to resolve this age-old debate. Rather, our hope is to show compatibilism bolsters our understanding of goal directed systems.

Coming back to the analogy we started with, the helium molecules in a balloon behave fully deterministically in their interactions with each other and with the molecules of plastic in the balloon wall. The movement of the balloon as it drifts about the room is also fully deterministic. And despite the fact that the molecules' absolute locations in space must roughly track the drifting of the balloon as a whole, their trajectories are nevertheless largely independent—nanosecond to nanosecond—of the movements of the balloon. At the small scale, the constraint on their freedom imposed by the movement of the balloon is negligible. Likewise my freedom to move about is constrained by the movement of the Earth around the Sun. I am forced to stay on this planet. But that hardly constrains my decision about where to go when I set out to find some coffee. I am free. And this is true despite the fact that my decisions are fully determined by my desires, and the fact that the movement of the Earth around the Sun is also fully determined.

Finally, let us return to Mayr's teleonomy. Recall that to legitimize the heuristic use of teleology, Mayr sought to carve teleology into teleomatic and teleonomic processes (while also arguing that evolution via natural selection is not a teleological process at all). Teleomatic processes are guided by natural laws, whereas teleonomic processes are guided by internal programs. Both processes, he argued, comport with mechanistic views of the world and causal explanations because natural laws and programs are mechanistically governed. Freedom, however, was obscured by pointing to the complexity of biological 'programs'. This was Mayr's way of cutting the difference between teleology and a causally determined world. Like the Epicureans, Mayr was looking for a swerve somewhere in nature. But now that we've seen that there is no tension between a deterministic account of the world and a world in which there are varying degrees of freedom, there's no need to introduce talk of programs, swerves or whatever else. Compatibilism shows that if internal parts are what determine actions, an entity is autonomous, and it can rightly be considered free. The third type of freedom within field theory, i.e. autonomous freedom, aligns with the compatibilist notion of freedom. Thus, compatibilist arguments for the possibility of freedom in a determined world support field theory's hierarchical understanding of goal-directed systems. Field theory just recognizes more types of freedom.

CONCLUSION

We believe it's time to move past the quest to reconcile freedom and teleology with all the 'isms' of sciences in the way that Mayr, the Epicureans and others have tried. It's a false dilemma because freedom and teleology have never been in any kind of conflict with a materialist, deterministic view of the world. We've shown that freedom is not an escape from determinism. It's a relation between an entity and a field, one that is organized in three different ways.

In addition to undermining the supposed conflict between freedom and determinism, field theory tells us where to look for freedom and how to recognize it when we see it. Freedom of the sort that is special to complex organisms is to be found in hierarchical structures, in the arrangement of entities nested within the fields that run so deep in these organisms. Freedom does not arise from the genes, or from internal programs of any kind, nor even from somehow overriding the genes. It requires no quantum effects or mysterious swerves. Rather, freedom is determined by these deep hierarchical relations. So teleology is the key to understanding freedom in these systems, and the first task of an investigation of freedom is locating the layers of hierarchical structure, and the boundaries among them, that give rise to teleology.

AFTERWORD

We should explain our choice of the term teleology, instead of teleonomy, which others in this issue have chosen. One common contemporary view of teleology is that it refers to the metaphysically suspect notion that some form of intentionality is present throughout the universe, in inanimate as well as animate matter, and that this intentionality accounts for all or most seemingly goal-directed behaviour, from human creativity to inert falling objects. Consistent with this view, many in recent decades see teleology as dated, some noting that Darwinian theory and the modern mechanistic worldview have eliminated the need for such a broad and mysterious concept.

But the whole notion could not be jettisoned, because obviously organisms can still be teleological, and so a new word – teleonomy – was coined by Pittendrigh (1958), ostensibly saving the phenomenon, preserving the piece of the core concept that applied to organisms and was thought to be scientifically investigable, restoring it to metaphysical respectability. Later, in a widely read paper, Mayr (1974) advanced a narrower understanding of teleonomy, limiting the term to organismal goal-directed behaviours that are directed by an internal program. This limitation of goal-directedness to organisms is one of the reasons we are reluctant to use the word teleonomy. In our view, some non-living systems are genuinely goal directed and indeed, we argue, all goal-directed systems whether animate or inanimate share a common structure. The commonality is physical, and we invoke no metaphysically suspect intentionality.

There is another reason for avoiding the word teleonomy. In adopting it, Pittendrigh and Mayr were both trying to distance themselves from Aristotle, from his metaphysics but also from his supposed 'externalism', the notion sometimes attributed to him that goal-directedness arises from outside of goal-directed entities, from the cosmos (or in later versions of Aristotelianism, from the mind of God). However, in a later 1988 reprint of his 1974 article, Mayr changed his position and added a postscript wherein he acknowledges some of the mistakes he made in 1974. Among these, he clearly states that he had misunderstood Aristotle's teleology (Mayr, 1988: p. 60). It is not cosmological and Aristotelian scholars widely agree that Aristotle's teleology is, in fact, far closer to an intrinsic teleology (see e.g. Johnson, 2005). In any case, as has been seen, our view is thoroughly externalist, finding the causes of goal-directedness in 'fields' that are external to goal-directed entities. Thus we do not share one of the main motivations Pittendrigh and Mayr seem to have had for distancing themselves from Aristotle, which was his supposed externalism. In fact, we believe an account of teleology that can be squared with mechanism demands some kind of externalism, just one that does not carry any extra metaphysical baggage (Babcock & McShea, 2021).

In sum, we opted against teleonomy because of the association with internalism and because of the separation it imposes between the living and the non-living. And we opted in favour of teleology, because it gestures at the historical understanding which accepts a commonality.

ACKNOWLEDGEMENTS

This article is a contribution to a special issue on *Teleonomy in Living Systems*, guest edited by Richard I. Vane-Wright and Peter A. Corning, based on a Linnean Society meeting held on 28/29 June 2021. We are very grateful to the organizers and participants of this conference for their feedback and suggestions. We would like to thank the John Templeton Foundation for its generous support (grant #61408, 'Increasing Complexity: The First Rule of Evolution?'), which helped make the work that contributed to this paper possible. And, finally we would also like to thank George Kassimis, Mark Brennan, Anne Sophie Meincke and an anonymous reviewer for their useful input on earlier drafts of this paper.

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