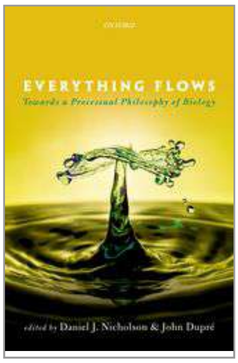

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Objectcy and Agency

Towards a Methodological Vitalism

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Abstract and Keywords

Organisms are like nothing else in the natural world. They are agents. Methodological vitalism is a view according to which the difference that organisms make to the natural world cannot be captured wholly if we treat them as mere objects. Understanding agency calls for a different kind of theory, an agent theory. Most of our scientific theories are object theories. The modern synthesis theory of evolution is a prominent example of object theory. Being the way it is, it cannot countenance the contribution to evolution that organisms make as agents. A comprehensive account of adaptive evolution requires an agent theory.

Keywords: agency, agent theory, evolutionary biology, methodological vitalism, modern synthesis, object theory, organism

1. Introduction

My objective here is to offer a methodological proposal predicated on a metaphysical position—neither of which has much credence or currency in modern philosophy of biology. The metaphysical position is that organisms constitute a special category of entity; they are natural agents. The methodological proposal is that, because organisms are agents, a genuine understanding of the difference they make to the world requires a battery of theoretical concepts and explanatory modes that do not apply to the study of non-living things. Organisms call for a special kind of theory, an agent theory. Most of our familiar scientific theories are not of this sort; they are object theories. The principal difference between agent theories and object theories resides in the way they treat the elements of their respective domains. I introduce two neologisms to mark the distinction: *objectcy* is the role played by the elements in the domain of an object theory, and *agency* is the role played by the elements in the domain of an agent theory. The proper study of organisms, I claim, requires us to take their agency seriously.

I call this agent-centred approach *methodological vitalism*. I am aware that the epithet 'vitalism' trails more than a whiff of odium in its wake. Vitalism, of the sort commonly associated with Hans Driesch and others, is roundly considered to be thoroughly discredited (Garrett 2013; Nicholson and Gawne 2015), even downright daft. In most cases the opprobrium is well earned. Prominent versions of vitalism in the late nineteenth to early twentieth century tended to set living things apart from non-living, on the supposition that they partake of a non-material vital substance, or are propelled or guided by non-material vital forces. I have no truck with this substance or ontological vitalism. But not all vitalisms are of this sort. The British Emergentist C. D. Broad advocates a form of materialism he calls 'emergent vitalism', according to which the behaviours of living matter cannot be adequately accounted for by the sciences of non-living things:

> [W]e have no right to suppose that the laws which we have discovered by studying non-living complexes can be carried over without modification to the very different case of living complexes. It may be that the only way to discover the laws according to which the behaviour of the separate constituents combines to produce the behaviour of the whole in a living body is to study living bodies as such.
>
> (Broad 1925: 68–9)

(p.168) E. S. Russell prefers the label 'organicism' but expresses a similar sentiment that living things engender new methods of study.[1]

> The living thing can be treated as a physico-chemical system or mechanism of great complexity, and no one would dream of denying the validity and value of biochemical and biophysical research. But such an approach leaves out of account all that is distinctive of life…I try to show that we cannot disregard these unique characteristics of life without losing all hope of building up a unified, coherent and independent biology.
>
> (Russell 1945: viii)

J. S. Turner (2013) credits the French developmental biologist Claude Bernard with a materialist form of vitalism.[2] Erwin Schrödinger, in his landmark essay

What Is Life?, encapsulates the idea that living things, while material entities, nevertheless make distinct methodological demands on the natural sciences:

> [F]rom all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics. And that not on the ground that there is any ‘new force’ or what not, directing the behaviour of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory.
>
> (Schrödinger 1944: 76)

Methodological vitalism locates itself in this tradition.

Vitalism of this sort pays a dividend to evolutionary theory. It has long been noticed that our best theory of evolution, for better or worse, relegates organisms to a marginal role, opting instead to prioritize genes and changes in ensembles of ‘gene ratios’.[3] I maintain that modern synthesis evolutionary biology doesn’t recognize the contribution of organisms to evolution for the simple reason that it can’t. It is the wrong sort of theory—an object theory. Insofar as it deals with organisms at all, it recognizes them only as objects. But, I claim, organisms participate in evolution as agents. Their contribution to evolution can only be adequately captured by an evolutionary agent theory. An evolutionary agent theory is an instance of methodological vitalism. It holds that the contribution of organisms to evolution demands a set of proprietary concepts and methods that apply exclusively to living things.

2. An Ontological Surprise

The primary substances of our commonsense ontology are objects. They are constituted of matter and take their definitive properties from their material constitution. These definitive properties are generally thought of as intrinsic causal dispositions, propensities to behave in certain ways when they encounter certain external conditions (Ellis 2001; Bird 2007). These properties in turn fix the individuation and persistence conditions of ordinary objects. They determine the kind of thing each entity is and the number, degree, and sorts of changes that each can undergo without ceasing to exist. Clearly, such things persist if they undergo no changes in their **(p.169)** material constitution. But not all primary substances are like that. Some things do not merely persist through change; they *subsist in change*. That is to say, their individuation and persistence conditions involve the constant exchange of matter and energy with the environment. They cease to exist when their material constitution ceases to change. This is a broad category of beings. It comprises cyclones, convective cells, flames, and much else besides.

Organisms constitute a special class of these *processual* objects. They subsist not merely by exchanging matter and energy with their environments, but through metabolism. Metabolism is the process by which an organism synthesizes the materials of which it is made. Through the exchange of matter and energy, the organism builds order internally while decreasing it in its environs. Such exchange is necessary for them to resist thermodynamic decay. Hans Jonas dubs the precarious mode of existence of organisms their ‘thermodynamic predicament’.[4] In coping with their predicament, organisms build themselves, organize themselves, and maintain themselves:

> [I]n living things, nature springs an ontological surprise in which the world-accident of terrestrial conditions brings to light an entirely new possibility of being: systems of matter that are unities of a manifold…in virtue of themselves, for the sake of themselves and continually sustained by themselves.
>
> (Jonas 1966: 79)

According to Jonas, an organism is not determined by the matter of which it is constituted—not in the way in which an ordinary object might be. Instead, an organism and its constituent matter stand in a dialectical relation of ‘needful freedom’:

> [T]his double aspect shows in terms of metabolism itself: denoting, on the side of freedom, a capacity of organic form, namely to change its matter, metabolism denotes equally the irremissible necessity for it to do so.
>
> (Ibid., 83)

In engaging in the metabolic struggle against its thermodynamic predicament, an organism creates and individuates itself. ‘The ontological individual, its very existence at any moment…its duration is, then, essentially its own function, its own concern, its own continuous achievement’ (ibid., 80). It is this unique capacity that makes organisms natural agents. As Di Paolo tells us, an agent is ‘a self-constructed unity that engages the world by actively regulating its exchanges with it for adaptive purposes that are meant to serve its continued viability’ (Di Paolo 2005: 442).

Quite how nature manages to spring this ontological surprise is the subject of vigorous investigation. Autonomous systems approaches to the study of complex entities offer a compelling account of how natural agents arise. The nature of natural agents is usually elucidated using a cluster of concepts: *closure, autonomy*, and *coupling*.[5] Varela (1979) defines *organizational closure* as a property of a bounded, unified system in which the component processes comprise a network, each of which depends on other elements of the network for its existence and maintenance. In a metabolically closed system, ‘each metabolite or enzyme needed for the maintenance of the system is **(p.170)** produced by the system itself' (Di Frisco 2014: 500). For Moreno and Mossio (2015: 23), this sort of closure is a 'general invariant of biological organisation'. They continue: 'Biological individuality, we think, has much to do with organisational closure, to the extent that one may conjecture that closure in fact defines biological individuality'.

Organizationally closed systems are autonomous. This is to say that they have the capacity to promote their own existence and to maintain their own structural and functional integrity across a range of internal and external conditions (Thompson 2007: 44). Because autonomous systems persist by exchanging matter and energy with their environments, they must be coupled with their environments. Coupling is the ability of the system to engage in the kind of reciprocal interactions with its environment that result in its continued viability.

Being an agent in this minimal sense, then, consists in an organizationally closed system's capacity to build and maintain itself through the exchange of matter and energy, to differentiate itself from its environment through this capacity, and to exploit its environment in ways that promote its own continued persistence (Barandiaran et al. 2009; Moreno and Mossio 2015). That is to say, an organism is not merely capable of engaging in these activities; doing so is a condition of its very existence. 'Its "can" is a "must", since its execution is identical with its being. It can, but it cannot cease to do what it can without ceasing to be' (Jonas 1966: 83).

Autonomous systems theory and related disciplines offer something of great value to philosophical naturalists. They give us an account of the place of organisms as agents in the natural world—of organisms as self-making, self-individuating, processual things. Moreover, the account accomplishes this in a way that requires no special methodological pleading. They tell us how the entities and activities that make up a system interact with one another to give rise to the definitive properties of an agent; and they do so in a way that requires only minor emendations to traditional mechanistic approaches to understanding the workings of complex entities (Bechtel 2013). Inportantly, they close a gap between living and non-living matter upon which the viability of substance vitalism appeared to depend: 'non-life and life share a huge and biologically significant territory that buffers and makes more complex any account of either' (Dupré and O'Malley 2013: 335). If traditional forms of vitalism raise a challenge to naturalism—that of specifying how arrangements of non-living matter can give rise to living organisms—then autonomous systems theory meets this challenge.

It is worth noting, however, that citing the mechanisms by which agents are realized might not be sufficient to account for the difference that agents make to the world. This has little to do with the special nature of agents, much less with any deficiency in autonomous systems theory. In general, it seems, understanding how complex material entities are realized is seldom sufficient for describing and explaining the ways in which the world is different as a consequence of their existence.

3. Phases

The ontological surprise that produces organisms is remarkable, but it is by no means one of a kind. The emergence of new phenomena in complex physical systems is the rule rather than the exception. As physical systems take on new configurations, they inaugurate new, highly distinctive properties, regularities, and relations that do not **(p.171)** exist in their absence. Understanding these new phenomena calls, in turn, for special theoretical concepts that are not required to account for domains in which these configurations do not occur. Typically, the new concepts are defined over the macrolevel behaviours of these new configurations of matter, quite independently of the details of their microlevel realizers (Morrison 2015). Examples are not hard to find. Phase transitions provide some of the most vivid cases.

As the early universe cooled and expanded, it underwent a series phase transitions (Gleiser 1998). In baryogenesis, thought to have occurred 10^{-32} seconds after the Big Bang, a phase transition breaks the symmetry between baryons and antibaryons, yielding a preponderance of the former (Coles 2000). At this point matter becomes more plentiful in the early universe than antimatter. This, in turn, facilitates the subsequent evolution of a stable material universe, which could not have occurred without a breaking of the baryon–antibaryon symmetry. Having stable matter in the world makes a difference (to say the least) that could not adequately be described without the proprietary concepts that describe the behaviour of matter, for example the concepts ‘quark’, ‘baryon’, or ‘meson’.

Further expansion and cooling of the early universe facilitated yet another phase transition, nucleosynthesis, which occurred between three and twenty minutes after the Big Bang. This transition saw the prevalence of protons over neutrons, which in turn produced the cocktail of light elements—H, ^{3}He—that make up the stars. We have stars and nuclear fusion, and eventually the heavier elements thanks to this phase transition. A world with atomic nuclei behaves differently from one without. In order to account for this behaviour we need concepts that apply exclusively to atomic nuclei, that is, to strong and weak nuclear forces (Coles 2000).

Analogously, if less exotically, the presence of fluids brings forth a whole new range of physical phenomena.[6] Fluids flow. Their flow may be laminar or turbulent. It generates lift and buoyancy. It may transfer heat through organiconvection cells. There are storms, ocean currents, tectonic flow—not to mention diffusion, buoyancy, surface tension, cell membranes, osmosis, erosion, flying, sailing, surfing, music, and beer—because there are fluids. Fluid dynamics, in turn, has its own proprietary theoretical concepts. Viscosity, for example, is essential to the explanation of the behaviour of fluids. Viscosity is realized as collisions between the particles that compose a fluid. Yet viscosity is not conceptually tied in any way to the microscopic conditions of its realization. It is defined in terms of its dynamics (Fulda 2016).Viscosity just *is* the resistance of a fluid to sheer forces.

In general, the explanations we find in fluid dynamics do not depend on citing the mechanical microconditions in which the macrolevel phenomena are realized. In fact it appears that we cannot account for all the phenomena that fluid dynamics explains by attending to the particles of a fluid. In order to explain the formation of droplets, for example, physicists employ an idealizing assumption that fluids are *not* made up of discrete interacting particles (Batterman 2005). Without this continuum assumption, the models of fluid dynamics cannot explain the propensity of fluids **(p.172)** to form droplets or to undergo phase transitions. Batterman argues that we should take seriously the idea that our models of fluid dynamics correctly identify physical discontinuities that we cannot adequately represent through the concepts of finite discrete particles and their interactions. The reason, in the case of droplets, is that 'the ultimate breakup profile is independent of the microscopic details of the breaking' (Batterman 2005: 242). The lesson can be generalized to all fluid phenomena. In fact, it holds true of an enormously broad and important class of sciences known as 'continuum mechanics', which deal with the macroscopic structural properties properties—tensile strength, conductivity, malleability, magnetism—of complex agglomerations of matter. These sciences all proceed on the assumption that macroscopic materials are continuous and non-particulate.

Typically, the macrolevel behaviours of these configurations have a significant degree of epistemic independence from their micro realizers: 'we need not appeal to the micro phenomena to explain the macro processes' (Morrison 2015: 105). The reason is that many of the macro regularities exhibit a comparable degree of 'metaphysical independence': 'most of the details of the [microscopic] arrangement, are irrelevant' (Batterman 2015: 133) at the scale at which the phenomena of interest are manifest. The upshot is that the account we offer of how these phenomena are realized may not have a particularly close relationship to and may form no real part of the account we provide of the difference they make.[7]

As with stable matter, atomic nuclei, magnets, superconductors, excitable media (Solé and Goodwin 2000), fluids, and tissues, so too, I suggest, with agents. A cascade of metaphysical consequences follows from the appearance of agents in the world. Where there are agents there are observable regularities, modal relations that just do not feature in non-agential worlds. The range of these new agential phenomena is no less interesting than other macrodynamic phenomena such as superconductivity, laminar flow turbulence, convection, magnetism, conductivity, or tensile strength.[8] They issue in explanatory demands that are no less challenging. Agential phenomena call forth a battery of theoretical concepts that are not needed to explain natural phenomena where no agents are involved. These concepts, too, manifest a significant degree of epistemic independence with the concepts we employ to explain how agency is realized in complex material systems. The moral of this methodological digression is that, as physical systems take on new configurations, they bring new phenomena into existence. These new phenomena, in turn, often call for new theoretical concepts.

4. Agential Dynamics

Because there are agents, there are goals, means, norms, hypothetical necessity, and a special mode of explanation—teleology. Goals are simply the end states that a goal-directed system tends reliably to attain and would reliably attain across a range of counterfactual circumstances. An agent's pursuit of its goals—its goal-directedness—is, **(p.173)** in turn, an observable feature of its gross behaviour. It consists in the agent's capacity to marshal its causal resources in a manner that brings about the reliable attainment and maintenance of an end state. So goals are an objective, natural feature of a world that contains agents. It is often thought that hypostatizing goals is antithetical to naturalism. Some insist that it commits us to intrinsically evaluable states of affairs (Bedau 1998). Others suppose that to be a goal is to be an object of thought, to be desired by a cognitive agent, or to be represented under the 'guise of the good' (Boyle and Lavin 2010). But, if agency is a kind of observable activity and goals are its end states, then the natural, non-psychological status of agency and goals is as unimpeachable as that of fluidity and viscosity.

If goals are natural, then so are means. Means are simply those elements of an agent's repertoire that are conducive to the attainment of its goals. Given the existence of goals and means, there is a special pair of modal relations between them. The relation that holds between goals and their means is hypothetical necessity (Fulda 2016). An agent will implement an element of its repertoire (often enough) because that action is necessary, under the circumstances, for the attainment of that agent's goal. It holds whenever, in a set of circumstances, the goal would not occur unless the means did. Hypothetical necessity is not a causal relation—goals don't cause their means, they hypothetically necessitate them—but it is a natural one nevertheless. Hypothetical necessity entails that, without the action in question, the goal would not have occurred and, with it, the goal it occurs reliably. Its dual is the relation of conducing. Whereas ends hypothetically necessitate their means, means conduce to their ends. Conducing is not the same as causing; *m* conduces to *e* only if *e* is a goal and, under the circumstances, *m* would reliably cause *e* across a range of counterfactual conditions.

Means occur *because* they conduce to agents' goals. Where there are agents, certain events occur reliably and predictably—because they are goals or means to them—that would otherwise occur only rarely and by chance. This robust counterfactual relation between goals and the activities of agents can be exploited in explaining why agents do what they do (Walsh 2012a). Explanations that cite goals in this way are teleological (Walsh 2008).

An agent has a repertoire, a range of activities that it can undertake in a given set of circumstances. On occasion, some elements of the agent's repertoire may be more conducive to the attainment of its goals than others. Hence it is possible to assess an agent's actions in respect of their appropriateness. Responses are appropriate if they are conducive to the agent's goals (or if they are hypothetically necessary).[9] In this way agency also issues in a form of natural normativity. Agents are normatively required to bring about those states of affairs that are hypothetically necessary for the attainment of their goals (Broome 1999).[10] So, where there are agents, there are natural norms too.[11]

(p.174) The relationship between an agent and its conditions of existence is not like the relation between a run-of-the-mill object and its environment. The two are in a sense intimate and non-separable. What the agent experiences and responds to in pursuit of its goals is a set of relational properties that have salience for the agent. These features, in turn, depend jointly on the features of the environment and on the goals and the capacities of agent. Kurt Goldstein captures the idea:

> The environment of the organisms is by no means something definite and static but is continuously forming commensurably with the organism's development and activity. One could say that the environment emerges from the world through the being or actualization of the organism.… Environment first arises from the world only when there is an ordered organism.
>
> (Goldstein 1995: 85)[12]

The relation that Goldstein points to is an ecological one. An agent's environment presents opportunities for, or impediments to, the attainment of its goals. In a word, agents experience and respond to their conditions as *affordances*. Affordance is a theoretical concept borrowed from J. J. Gibson's ecological theory of perception.

> The affordances of the environment are what it offers the animal, what it *provides* or *furnishes,* for good or ill…I mean by it something that refers to both the environment and the animal… It implies the complementarity of the animal and the environment.
>
> (Gibson 1979: 127)

Affordances are not environments. They are emergent phenomena that, once again, only exist where there are agents. To be an agent is to respond to one's conditions as promoting or impeding the pursuit of goals; to be an affordance is to be a set of conditions that are salient to an agent's pursuit of its goals. 'Affordances are opportunities for action; they are properties of the animal–environment system that determine what can be done' (Stoffregen 2003: 124).

There is a relation of reciprocal constitution between an agent's abilities and its affordances. Affordances determine what an agent can and should do, given its goals and its repertoire. Conversely, the goals and repertoire of an agent determine what its conditions of existence afford. Moreover, as organisms change in response to their affordances, so too do the affordances. In turn, a change in affordances alters what the agent can do. This sort of constitutive reciprocity between an entity and its conditions (i.e. affordances) exists only where there are agents.[13]

All in all, the presence of agents in the world makes quite a difference. Agents behave in a wholly distinctive way, and in so doing they introduce a range of new phenomena, relations, and regularities that do not figure in the ontology of an agent-free world. Consequently we need a battery of theoretical concepts and methods to describe this range of facts: *goal, means, affordance, repertoire, salience, reciprocal constitution, normative requirement, hypothetical necessity, teleology*. Note that these concepts that describe the ontological consequences of agents are defined in terms of agents' gross behaviour. They are not defined in terms of the microscopic realizations of agency. This is the reason why autonomous systems theory (and related fields), **(p.175)** while giving us a compelling mechanistic account of how agents are realized in the natural world, do not provide an account of the difference they make.

In this respect, the concepts we need in order to capture the differences that agents make are of a piece with the theoretical concepts of viscosity or weak and strong nuclear forces, excitable media, or superconductivity. They pick out macrolevel phenomena that enjoy a degree of epistemic independence over the details of their realization. There is an important difference, however, between (say) fluid dynamics and agent dynamics. The concepts we invoke to describe the dynamics of agents involve us in a non-standard kind of scientific theory. This will need a little explaining.

5. Object Theories and Agent Theories

I began this chapter with the claim that the elements of our common-sense ontology are objects, defined and individuated by their material constitution. Scientific theories by and large are structured expressly to deal with them; they are object theories. Organisms are fundamentally different kinds of things; they are agents. In this section I want to suggest that this metaphysical difference raises a methodological problem for any science that seeks to encompass the difference that organisms make to the world. In particular, an object theory encounters a specific kind of difficulty in articulating the contribution that organisms make to evolution. Object theories are not aptly suited to doing so. For that we need a different kind of theory, an agent theory.

5.1. Objectcy

An object theory seeks to describe and explain the changes in a domain of objects by setting out a space of possible alternatives for those objects—a state space—and by articulating principles that account for the possible trajectories of the objects through the state space. Objects play a specific role in object theories; I shall call it 'objectcy'. Objectcy consists in the fact that the elements of the domain remain unaltered (with respect to the theory's conserved quantities) unless they are influenced by external sources of change. Objects do not initiate their own changes in the state space. The principles we call upon to explain their changes—for example laws of nature, initial conditions, the space of possible configurations—are exogenous to the objects. In an object theory, the laws of nature and the state space remain constant as the objects traverse the space. The physicist Lee Smolin (2013) has associated this type of theory to what he calls the 'Newtonian paradigm'. According to Smolin, theories in the Newtonian paradigm pose two simple questions: '(i) what are the possible configurations of the system? and (ii) what are the forces that the system is subject to in each configuration?' (Smolin 2013: 44).

Object theories are marked by a kind of transcendence of the explanatory principles over the objects in the domain. The laws, the initial conditions, and the state space exist independently of the objects. They are 'givens'. They remain constant as the objects change. This in turn introduces an explanatory asymmetry between the principles and the objects. The principles explain the changes to the objects in the domain, but the objects do not explain the principles. We cannot, for example, look to the motions of the planets to explain why the laws of gravitation are as they are. Nor can we cite the structure of atoms to explain why the strong, weak, and electromagnetic forces are as they are.

(p.176) 5.2. Agency

In an agent theory, the elements of the domain take on a much different role. For want of a better word, I shall call it 'agency'. Agency consists in the fact that the elements of the domain (the agents) initiate their own changes. Agents and the principles we call upon to explain their behaviour have a particularly intimate relation. Agents initiate changes in the state space in response to their affordances, which are jointly constituted of the agents' goals, capacities, and their external circumstances. Agents and affordances are in this sense 'commingled'. The range of possibilities open to an agent (the state space) is itself determined jointly by that agent's condition and capacity to respond to them. Moreover, the conditions, the possibilities, and the capacities of agents co-evolve. As agents change in response to their conditions, so do the conditions. And, as the conditions change, so does the range of possibilities open to the agent (i.e. the state space).

Whereas object theories are characterized by transcendence and explanatory asymmetry, agent theories are characterized by what I shall call ‘immanence’ and ‘explanatory reciprocity’. An agent’s conditions and its capacities to act are immanent in the agent’s engagement with its environment. The conditions that agents experience and their capacities to respond to them are interpenetrating and interdefining; each partially constitutes the other. Because the conditions and agents constitute one another and co-evolve, each can be (partially) explained by appeal to the other. The activities of the agent can be explained as a response to its conditions and, reciprocally, the change in conditions can be explained as a consequence of the activities of the agent.

Good examples of agent theories are a little thin on the ground, but Lee Smolin (2013) has recently made a quite surprising proposal. Smolin argues that the Newtonian paradigm has failed to generate a theory that governs all of the physical world, because it delivers the wrong kind of theory. The best that such a theory can do is tell us that, *given* the laws and some initial conditions, the universe should evolve in such and such a way. But it could not tell us *why* these initial conditions and these laws obtain. This is a deficiency; these questions presumably have answers. However, the answers do not fall within the ambit of the theory. Smolin finds this unsatisfactory from a theory of everything: ‘Nothing outside the universe should be required to explain anything inside the universe’ (Smolin 2013: 121–2). The complete theory of the universe must abandon the Newtonian paradigm; ‘the remedy must be radical, not just the invention of a new theory but…a new type of theory’ (Smolin 2013: 250). The new type of theory Smolin envisages is one in which the laws of nature and the principles that explain how the universe changes evolve as the universe does, in such a way that each explains the other. As the universe evolves, as it grows and complexifies, the laws, the conditions, and the space of possible states will also evolve (Smolin 1997). Smolin is calling for an agent theory of the universe.[14]

(p.177) Whether or not an agent theory of everything is in prospect, the emergence of organisms as agents in the natural world at least provides the opportunity for the development of a more modest example. The purposive behaviour of organisms and their relation to their conditions of existence exhibits the sort of immanence and reciprocity that call for an agent theory.

As indicated above, the concepts and methods we need in order to articulate an agent theory of organisms are already to hand: *goal, means, affordance, repertoire, salience, reciprocal constitution, normative requirement, hypothetical necessity, teleology*. These theoretical tools exhibit the distinctive marks of an agent theory: immanence, reciprocity, and co-evolution. For example, we do not fully understand the response of an agent to its conditions unless we understand what those conditions afford the agent. But we do not understand what an agent's situation affords the agent unless we know the agent's goals and its repertoire. Nor do we understand the evolution of an agent's actions over time, unless we grasp how these actions alter its affordances, which in turn structures its range of possibilities. Further, a successful explanation of the actions of a well-functioning agent will need to show that the conditions, repertoire, and goals of the agent didn't merely *cause* the response, they normatively required it. It will need to show us that the agent ought to have done what it did, in order to achieve its goal. Explanations of agency qua *agency* are, thus, teleological.

We have got this far. Agents make an ontological difference to the world. They usher in a range of phenomena—goals, means, normative requirements, and so on—and call for the sort of explanations that do not feature in agent-free worlds. In order to capture the difference that agents make, we need an agent theory. Organisms are agents by their nature. If what makes organisms organisms makes a difference to evolution, then it would seem that we could only fully account for their contribution with an agent theory of evolution.

6. Evolution and Agency

Modern synthesis evolutionary theory is an object theory. It conforms nicely to the Newtonian paradigm. Its objective is, inter alia, to explain the presence and prevalence of organismal traits. Organisms occupy the objectcy role. The space of alternatives is traditionally represented as a fixed landscape of phenotypes and their fitnesses (McGhee 2007). Populations of organisms are propelled through this space by exogenous forces of selection and drift (Sober 1984). Organisms occupy a marginal place in modern synthesis thinking. They are the products of the activities of more fundamental entities—replicators; and the victims of their own external conditions—the environment. As Richard Lewontin puts it, modern evolutionary theory

> is a theory of the organism as the *object,* not the subject, of evolutionary forces. Variation among organisms arises as a consequence of internal forces that are autonomous and alienated from the organism as a whole. The organism is the object of these internal forces, which operate independently of its functional needs or of its relations to the outer world.
>
> (Lewontin 1985: 87; emphasis added)[15]

(p.178) The resonances with the Newtonian paradigm are clear, as Lewontin emphasizes. There is nothing about the objects of the domain—organisms—that answers Smolin's two questions: (i) 'what are the possible configurations?'; and (ii) 'what are the forces?'. The possible configurations comprise the set of phenotypes made by gene combinations and their fitnesses as determined by their environments. The forces are selection, drift, and mutation, all things that *happen to* organisms.[16] Organisms initiate no evolutionary changes of their own. Lewontin continues:

> Thus classical Darwinism places the organism at the nexus of internal and external forces, each with its own laws, independent of each other and of the organisms that is their creation.…The organism is merely the medium by which the external forces of the environment confront the internal forces that produce variation.
>
> (Lewontin 1985: 88)

The environment is wholly autonomous of organisms. It has the capacity to mould form so as to meet its exigencies while remaining unaffected by organisms themselves.[17]

> Organisms respond to the environment, but the environment is largely autonomous with respect to the organisms. The environment is seen as either stable (as far as the time scale of the evolutionary process in question is concerned) or else as changing according to its own intrinsic dynamics.
>
> (Godfrey-Smith 2001: 254)

The autonomy of the environment and the explanatory asymmetry of environment over form are hallmarks of the objectcy of organisms in the modern synthesis.

There is much about the process of evolution that the modern synthesis, like any theory in the Newtonian paradigm, leaves unexplained. The range of variants available to selection is fixed by random mutation, not by the properties of organisms. The good locations in fitness space are determined by the environment (McGhee 2007). These are ‘givens’ that fall beyond the purview of evolutionary theory.[18]

Lewontin has long been an outspoken critic of these defining features of the modern synthesis. He rejects the detachment (the ‘alienation’) of organism from environment that is so central to the modern synthesis. He objects to the modern synthesis portrayal of organisms as simply effects of the activities of genes, subject to the vicissitudes of their environments. Furthermore, he rejects the autonomy and asymmetry of the organism–environment relationship:

> First, it is not true that the development of an individual organism is an unfolding or unrolling of an internal program.… Second, it is not true that the life and death and reproduction of an organism are a consequence of the way in which a living being is acted on by an autonomous environment.
>
> (Lewontin 1978: 89)

Lewontin counters that the conditions to which organismal form evolves are strictly underdetermined by the features of the external environment. The reason is that the **(p.179)** external environment underdetermines the way in which the organism *experiences* the environment. The difference between the external environment and the 'experienced environment' arises from the contribution of organisms. Lewontin stresses that organisms actively participate in creating the conditions to which biological form evolves: 'the environments of organisms are made by organisms themselves as a consequence of their own life activities' (ibid., 64). This co-constitution of organism and its conditions has implications for natural selection:

> Natural selection is not a consequence of how well the organism solves a set of fixed problems posed by the environment; on the contrary, the environment and the organisms actively co-determine each other.
>
> (Ibid., 89)

In light of this, Lewontin has repeatedly called for a revision of the modern synthesis conception of organism–environment relations. His own version is remarkably reminiscent of Gibson's, and indeed of Goldschmidt's (both quoted above):

> There is no organism without an environment, but there is no environment without an organism. There is a physical world outside of organisms and that world undergoes certain transformations that are autonomous.… But the physical world is not an environment, only the circumstances from which environments can be made.
>
> (Ibid., 86)

Organisms contribute to the conditions under which they evolve in myriad ways. Their own size, structure, behaviour, physiology, and development determine the ways in which environmental features impact on organisms. They actively select which features of the environment are relevant for their survival. They change the features of their external environments (Odling Smee et al. 2003).

While Lewontin's critique emphasizes the capacity of organisms to influence their experience of the external environment, it must also be noted that organisms have an influence on their own adaptive repertoires. They achieve this through a variety of means. Organisms respond to environmental stresses by regulating the genome's structure and function, for example through adaptive DNA methylation (Dowen et al. 2012; Herman and Sultan 2016). One particularly prominent form of genome regulation is found in intracellular genetic engineering processes (Shapiro 2013). Organisms reconstruct their genomes in response to their conditions. The single-celled eukaryote *Oxytrichia trifallax*, for example, excises over 90 per cent of its somatic genome and reorganizes the rest (Chen et al. 2014).[19] This is an extreme example, but not an especially exotic one. The engineering of the genome by the organism is commonplace. Cells actively cut, transpose, copy and fix their genomes. They do so in highly sensitive, adaptive ways:

> Cells operate under changing conditions and are continually modifying themselves by genome inscriptions…Research dating back to the 1930s has shown that genetic change is the result of cell-mediated processes, not simply accidents or damage to the DNA. This cell-active view of genome change applies to all scales of DNA sequence variation, from point mutations to large-scale genome rearrangements and whole genome duplications.
>
> (Shapiro 2013: 287)

(p.180) The understanding of genome function is itself shifting (Barnes and Dupré 2008). The genome is no longer seen as embodying a program for building an organism. Rather, it is increasingly considered an ‘organ’, under the control of the cell and of the entire organism:

> [I]t is more accurate to think of a cell’s DNA as a standing resource on which a cell can draw for survival and reproduction, a resource it can deploy in many different ways, a resource so rich as to enable it to respond to its changing environment with immense subtlety and variety.
>
> (Keller 2013: 41)

The control that the organism exerts over the capacities of the genome is an important part of the organism’s adaptive, purposive response to its conditions. Even individual cells manifest this adaptive agency:

> A major assertion of many traditional thinkers about evolution…is that living cells cannot make specific, adaptive use of their natural genetic engineering capacities. They make this assertion to protect their view of evolution as the product of random, undirected genome change. But their position is philosophical, not scientific, nor is it based on empirical observations.
>
> (Shapiro 2011: 55–56)

Organisms adaptively regulate their own repertoires in other ways too. One vivid example is found in the plasticity of development.[20] Plasticity achieves a number of functions in evolution. It initiates new forms. ‘Responsive phenotype structure is the primary source of novel phenotypes’ (West-Eberhard 2003: 503). By permitting the development of the organism to accommodate to its circumstances, plasticity buffers the organism against the deleterious effects of perturbations. ‘Phenotypic accommodation reduces the amount of functional disruption occasioned by developmental novelty' (ibid., 147). Phenotypic plasticity orchestrates the development of complex adaptations. The evolution of complex adaptations requires coordination between an organism's various developmental systems. For example, the adaptive evolution of tetrapod limb structures requires coordination between the development of bone, muscle, nervous, circulatory, and integumentary systems (at least). If each system had to wait for a fortuitous mutation in order to produce the appropriate accommodation, complex evolutionary adaptations might never arise (Pfennig et al. 2007). These are all ways in which organisms regulate their repertoires. By altering their capacities in response to their conditions, of course, they also further change their affordances.

One of the dominant themes of twenty-first-century evolutionary biology has been the discovery of the active role of organisms in evolution. Yet we are lumbered with a theory of evolution, the gene-centred modern synthesis, that gained its enormous influence under the supposition that the contribution of organisms to evolutionary dynamics is negligible (Walsh 2007).[21] Modern synthesis evolutionary thinking typically excludes developmental plasticity, learning, cultural transmission, behaviour (Bateson and Gluckman 2011; Vane-Wright 2014; Bateson 2014; Corning 2014) and **(p.181)** ecological engineering (Turner 2000) from its roster of evolutionary processes. It is imperative that we incorporate these factors into our account of evolution (Laland et al. 2014).

Perhaps it is possible to extend or amend the modern synthesis so as to make it accommodate these insights (Pigliucci and Müller 2010). Perhaps it can happily assimilate the activities of organisms without undergoing any major rejigging (Wray et al. 2014). But the very structure of the modern synthesis suggests otherwise. It is an object theory. Object theories, as we have seen, do not represent agency *as agency*. Yet the contributions that organisms make to evolution are consequences of their agency. I suggest that the modern synthesis has consistently failed to assimilate organisms into evolutionary thinking because it is constitutionally incapable of doing so. It is the wrong kind of theory. Perhaps what is needed, as Smolin suggests for cosmology, is a radically new kind of theory of evolution, an agent theory.

An agent theory would represent adaptive evolution as following from the adaptive, purposive engagement of organisms with their affordances. An evolutionary agent theory would emphasize the endogenous source of changes in form. In doing so, it would encompass the 'immanence' and 'reciprocity' of the relation between form and affordance. It would also acknowledge the role of organisms in securing the high-fidelity inheritance of characters. It would be sensitive to the ways in which the affordances that impinge on an organism are not imposed on it exclusively by exogenous factors but are rather the joint product of the organism's own capacities and the features of its setting. It would also underscore the co-evolution of form and affordance. In responding adaptively to conditions of existence, organisms alter their affordance landscapes. These altered affordances, in turn, redound to organisms. The conditions to which adaptive evolution responds explain the evolution of form, and changes in form explain the evolution of the conditions. The organism's contribution to evolution consists in its capacity to respond to perturbations, to maintain its viability, and to innovate. The novelties that provide the raw materials of evolution, the conditions to which the evolution of form responds, the possible trajectories through state space—these are not *given*. They are *constructed* by organisms' purposeful engagement with the world. They are manifestations of the agency of organisms. It is the objective of an agent theory of evolution to capture the contribution of this ecological dynamics to evolution.

7. Conclusions

Darwin's theory of descent with modification established that those 'endless forms most beautiful and most wonderful' are the consequence of the 'struggle for existence'. The simple, elegant idea is that evolution happens because of what organisms do. Yet this insight has been comprehensively lost from the modern synthesis theory of evolution. Evolution, on the modern synthesis view, happens because of what genes do. According to the modern synthesis, organisms are objects of evolutionary forces, middlemen built by genes and selected by, and alienated from, their environments. They are passive with respect to the genuinely evolutionary processes. Recently, however, the significance of Darwin's insight that evolution happens because of what organisms do is beginning to receive renewed attention.

(p.182) What organisms do is quite unlike what any other natural entities do. Organisms constitute a distinct ontological category. They are a special kind of processual thing; they are agents. The existence of agents ushers in a range of natural phenomena, regularities, and modal relations that are absent from an agent-free world. These include goals, means, affordances, norms, and hypothetical necessity. Agency is an ecological phenomenon. It is the process by which a goal-directed system marshals the resources of its adaptive repertoire in response to the affordances it both experiences and makes. In responding to their affordances, organisms create the conditions under which they evolve. In this way organisms enact evolution. The proper representation of this ecological dynamics requires a special kind of theory, an agent theory of evolution. That theory, in turn, deploys a battery of concepts and methods that have no place in the study of the non-living world. Methodological vitalism is the view that evolution should be studied from the perspective of the distinctive role that agents play in enacting evolution.

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Notes:

([1]) The various species of vitalism and organicism are nicely surveyed by Nicholson and Gawne 2015 and by essays in Normandin and Wolfe 2013. On organicism, see also chapters 1, 7, 11, 12, and 13 here.

([2]) Turner 2013 calls Bernard's position 'process vitalism'.

([3]) The reasons for the marginalization of organism are discussed extensively in Walsh 2015.

([4]) I am grateful to Alex Djedovic for helpful discussions on this issue. See chapter 7 for a complementary examination of this topic.

([5]) For various versions of this approach, see Varela 1979; Thompson 2007; Barandiaran et al. 2009; and Moreno and Mossio 2015. Chapter 10 in this volume also exemplifies this approach.

([6]) See Fulda 2017 for an extended discussion on the example of viscosity. I thank him for his help here.

([7]) Fulda 2017 beautifully illustrates the way in which naturalizing a phenomenon consists of two distinct stages: (i) locating it in the causal structure of the world; and (ii) constructing a theory of the difference it makes. These two stages may have varying degrees of independence.

([8]) I am also suggesting that they are no more arcane.

([9]) I take it that conduciveness is only sufficient for appropriateness.

([10]) I contrast this approach to natural normativity with that offered by Barandiaran et al. 2009. These authors only acknowledge the normative requirement for an agent to promote its own persistence. But agents are generally capable of pursuing a range of goals, each of which normatively requires its means. Again, I am indebted to Alex Djedovic here.

([11]) Philosophical folklore has it that you can’t derive an ‘ought’ from an ‘is’. Maybe so. Nor can you derive continuum mechanics from the finite arrangement of discrete particles, but that does not impugn the naturalness of either continuum mechanics or normativity.

([12]) The original German language version, *Aufbau des Organismus*, appeared in 1935.

([13]) These ideas are developed in more detail in Walsh 2012b and Walsh 2013.

([14]) Clearly an entity does not need to be an ‘agent’ in the sense outlined by autonomous systems theory to be the element of an agent theory. My supposition, however, is that the fact that organisms are agents (in the latter sense) necessitates an agent theory to describe them. I thank Lee Smolin for a helpful exchange around this view.

([15]) I thank Jonathan Kaplan for pointing out quite how germane this passage is.

([16]) The other putative force, migration, is evidently something that organisms do.

([17]) Niche construction theory (Odling-Smee et al. 2003) amply demonstrates the implausibility of the supposition of environmental autonomy over biological form. But niche construction theory retains the explanatory externalism of the Newtonian paradigm (see Walsh 2012b).

([18]) See Wagner 2014 for a compelling argument that the origin of evolutionary variants should not be treated as a primitive given by evolutionary theorists.

([19]) I thank Greg Rupik for drawing my attention to this example.

([20]) The plasticity of development is discussed at length in chapter 12.

([21]) It was not intended to be that way by those who forged the modern synthesis. Mayr and Dobzhansky, for their part, insisted that individual organisms make a substantive contribution to adaptive evolution. See Depew 2017 for an enlightening discussion.