Narratives & Mechanisms

Abstract

Historical scientists are frequently concerned with narrative explanations targeting single cases. I show that two distinct explanatory strategies are employed in narratives, *simple* and *complex*. A simple narrative has minimal causal detail and is embedded in a general regularity, whereas a complex narrative is more detailed and not embedded. This distinction's importance is illustrated in reference to mechanistic explanation. I consider 'liberal' accounts of mechanistic explanation, which expand the traditional picture to accommodate less mechanistic sciences. Simple narratives warrant a mechanistic treatment, while some complex narratives do not.

Introduction

Scientists examining the past are taken to be primarily concerned with *narrative* explanations which account for single events[1]. A meteor exterminated the dinosaurs; New Zealand's lake Taupo was formed by an enormous volcanic eruption; the introduction of small-pox killed millions in the Americas. Of course, historical scientists are not narrowly concerned with narrative explanation. As Kosso (2001) and Jeffares (2008) discuss, they sometime target middle-range theories which connect contemporary phenomena to past events (see also Turner 2009). Moreover, much historical enquiry targets patterns and regularities in deep time. Paleobiological work covering the nature of mass extinction events (Raup 1991) the nature of speciation (Eldredge & Gould 1972), the role of selection and adaptationist explanations in macro-level patterns (Gould et al 1977, Huss 2009), are all concerned with regularities in life's shape, not the explanation of a simple event. However, at least much of the time their explanatory interests are geared towards the particular rather than the general. This paper shows that historical explanation, understood as narrative, is disunified: at least two distinct explanatory strategies are employed. *Simple* narratives explain particular cases as instances of regularities – the explanandum is subsumed by a general model. *Complex* narratives do not account for explananda in terms of regularities or models.

I argue that simple narratives have more in common with the population-level explanations furnished by economists and ecologists than complex narratives. This is demonstrated by comparing narrative explanations with mechanistic models. Both population-level and simple narratives are amenable to

[1] For example, Kitcher 1993, Cleland 2011, Hempel 1965 and Hull 1975 appear to agree that historical enquiry is primarily narrative

mechanistic gloss. However, in complex cases scientists are not typically mechanists. Faced with a complex world, they employ characteristically non-mechanistic explanations.

The paper is in three parts. In the first, two case-studies illustrate the distinction between simple and complex narratives. Part two discusses mechanistic explanation, sketching the view and introducing liberalism – the view that most or all scientific explanation is mechanistic. The third part examines narrative explanation in light of mechanistic explanation, arguing that simple narratives are characteristically mechanistic, while some complex narratives are not.

1. Narrative Explanations

Narrative explanations account for particular events[2] via causal sequences concluding with the explanandum. The causal sequence makes the explanandum likely. Narrative explanations are taken to be distinctively historiographical (at least by Hempel and Hull) due to their 'story-like' structure and lack of appeal to laws. The treaties at the close of the First World War led inevitably to the Second; the extraterrestrial impact which caused the Chicxulub crater was sufficient to exterminate the dinosaurs; and so on. There is more than one way to account for an event, however. Some causal sequences stand alone: even if only one extinction event was caused by an impact, we can be convinced of the impact's causal sufficiency. Or we might explain an event as an instance of a general model: perhaps all wars have common causes, and the Second World War can be explained in terms of those commonalities.

I will be agnostic as to whether all narratives in fact reference regularities, and whether this is problematic. Hempel's primary concern about historiographic explanation is the lack of nomological appeals and I (in part) share the suspicion that particular events can be satisfactorily explained without recourse to regularities (c.f Tucker 1998) but my claim of the disjunctive nature of narratives holds regardless of this.

Hopefully it is clear that narrative explanations are surely not restricted to historiographical inquiry – there is nothing stopping a chemist explaining a single event in terms of some causal sequence (perhaps even without explicit mention of laws) - and therefore the claims I make about narrative explanation will most likely not be restricted to the geological and paleontological cases I focus on. Whether the distinctions and lessons I draw are extendable to other sciences I leave for future work: given that

[2] I will speak in terms of past events, but historical enquiry also covers historical processes, entities and states of affairs. The claims made about events carry over to those other types of targets.

narrative explanation is paradigmatically the business of historical inquiry, it is the obvious place to center philosophical investigations

And so narrative explanations (1) account for some particular explanandum in terms of some causal sequence; (2) may or may not appeal explicitly to laws or generalizations; (3) are paradigmatically, but not exclusively, historical. I argue that there are two explanatory strategies which historical scientists employ in providing narratives.

1.1 Snowball Earth

There were glaciers in the tropics at least twice during the Neoproterozoic (roughly 1000 – 542 million years ago). Towards the end of the period there was synchronous, ubiquitous glaciation: the entire earth covered in permafrost cut through by rivers of ice. This presents a series of geological and palaeoclimatological challenges. What could have caused this scenario? How did it thaw? Why are such events rare? The most popular explanation of these glacial events is Joseph Kirschvink's Snowball Earth Theory (Schopf & Klein 1992, Hoffman & Schrag 2002).

The late Neoproterozoic was a time of continental dispersal: the supercontinent Rodinia broke up and the megacontinent Gondwana began to form. During glacial periods most continents clustered at the middle and lower latitudes. Kirshvink proposed that this clustering was responsible for the global freeze.

Both land and ice-caps have high albedo – they reflect more of the sun's energy than water. Tropical landmasses have high albedo because more sunlight reaches the equator. Their warm, moist climate also increases silicate weathering (the absorption of $C0_2$). Land clustering around the tropics, then, increases albedo and decreases greenhouse gases. This would lower the earth's temperature – particularly at the poles where the growth of ice sheets would lead to a freezing feedback loop:

> If more than about half of the Earth's surface area were to become ice covered, the albedo feedback would be unstoppable… surface temperatures would plummet, and pack ice would quickly envelope the tropical oceans (Hoffman & Schrag pp 135)

The explanation can be presented in a simple flowchart:

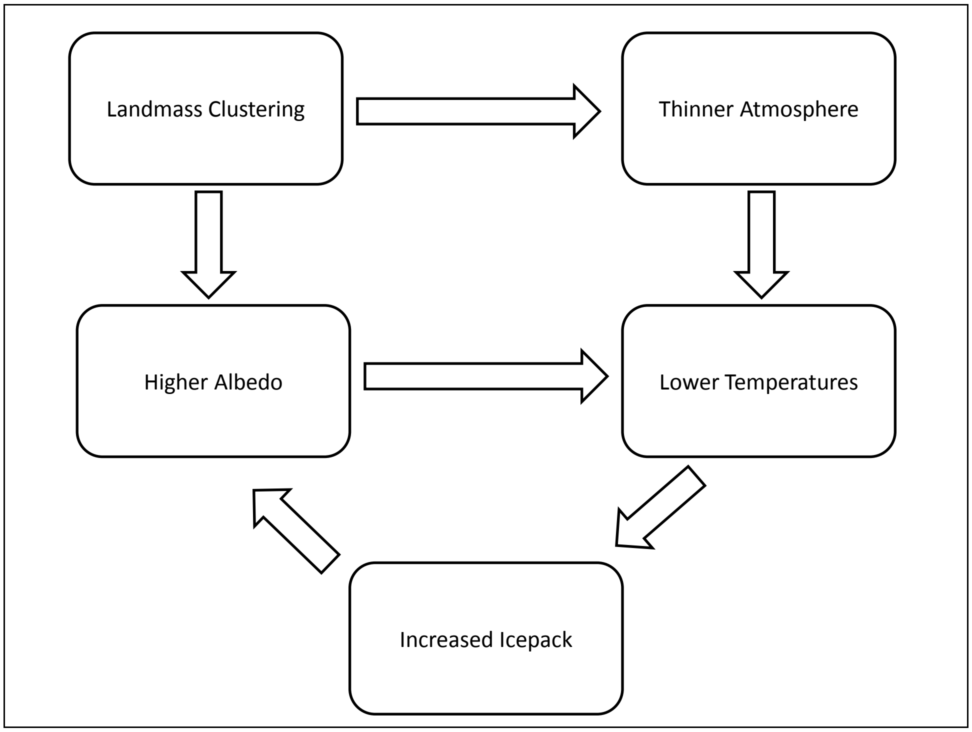

Figure 1: Snowball Earth

Landmass clustering in the tropics lowers temperature by increasing albedo and thinning the atmosphere. Lower temperatures increase icepack cover, creating a feedback loop between lowering temperatures, larger icecaps, and higher albedo. Earth freezes over. As we shall see, Snowball Earth is a paradigm 'simple' narrative: an event is explained by a general model with reference to minimal causal factors.

1.2 Sauropod Gigantism

Despite public perception, most dinosaurs fit comfortably in the familiar mammalian size-range. The sauropods were different: not merely big, but puzzlingly so. Some were the largest land animals to have ever lived: *Sauroposeidon* and *Argentinosaurus* are estimated to have weighed between 50 and 70 tons, rivaling baleen whales in length. By contrast, the largest known terrestrial mammal was *Paraceratherium*, thought to be 12 meters long and weighing 20 tons at most. How did sauropods manage such sizes? Why was it unique? How was gigantism physiologically and evolutionarily possible?

As Sander, Christian et al (2011) review, sauropod gigantism was the result of myriad causes (see also Klein et al 2011). Sauropods were the right lineage, in the right place, at the right time. They had specific primitive characteristics which removed size limitations. Early sauropods were oviparous – egg-laying allows for fast population recovery, mitigating the small population size engendered by gigantism. They did not masticate, increasing food intake. They had a distinctive small-head-and-long-neck morphological structure, which maximizes grazing range while minimizing movement.

These primitive characteristics were supplemented by new adaptations. Gigantism itself protected against the increasingly sophisticated predators of the Jurassic, and accommodated the enormous digestive system mitigating the lack of mastication and gastric mill. Their basal metabolic rate increased to accommodate the speedy growth required. Sauropods evolved a distinctive pneumatized skeleton, a signal of a bird-like respiratory system, which increases the efficiency of oxygen dispersal and accommodates the growth rate required to reach gigantic size.

The road to gigantism was open to sauropods due to their distinctive primitive characteristics. The road was followed due to the evolution of particular adaptations in response to particular evolutionary pressures. The explanation of sauropod gigantism is a complex narrative: there is no appeal to a general model in explanation, but rather a unique, detailed causal sequence is employed.

1.3 Simple & Complex Narratives

In explaining snowball earth and sauropod gigantism historical scientists follow two distinct explanatory strategies. Both are narrative explanations: their explananda are individual cases, accounted for via particular causal sequences. However, snowball earth is explained as an extreme case of a general model. Sauropod gigantism is not. Moreover, the Snowball Earth contains less causal detail than sauropod gigantism. The geological case is *simple,* while the paleobiological case is *complex*[3]. Two features, an explanation's *detail* and *embeddedness*, are characteristic of simple and complex narratives. It is worth reiterating that these distinctions may well illuminate sciences not typically considered historical, or dealing with narratives. It is beyond this paper's scope to discuss such cases, but I take it that if simple and complex explanations of particular events occur in ahistorical sciences, this only strengthens the importance of the distinction.

Detail

A striking difference between the two explanations is the level of *detail* required. Detail is a measure of the specificity, complexity and diffusion of the explanans required for explanatory adequacy. Snowball

[3] The distinction between complex and simple is similar in spirit to 'actual sequence' and 'robust process' explanations (Sterelny 1996, Jackson & Pettit 1992), although is not cashed out in overtly modal terms.

earth is low- detail: few factors and a single difference-maker are required. General facts about global albedo, temperature, atmosphere and icepack work in tandem with particular facts about landmass clustering to produce the explanandum. Sauropod gigantism, by contrast, requires a more detailed explanation. Adequacy requires many explanans, quite disparate in nature. Important explanatory details are spread through time: from deeply primitive characteristics such as oviparity, to highly derived ones like pneumatization. Explanans are also spread across grain: oviparity is important because it mitigates evolutionary, population-level concerns while pneumatization solves individual-level, physiological concerns.

Detail, then, tracks the complexity required for explanatory adequacy, and its nature depends in part on the explanandum. In the snowball earth case, the world cooperates in granting sufficiency to low detail explanations while for sauropod gigantism the distended, messy nature of the explanandum demands a more detailed, messy explanation.

Embeddedness

A narrative explanation is *embedded* when the explanandum is accounted for as a token of a type of process; an instance of a regularity. The relative simplicity of the snowball earth explanation allows it to be represented by a single climatological model. The hypothesis is an extreme case of run of the mill dynamics between ice cover, geography, climate and atmosphere. In explaining why the earth froze, I tell you about those general dynamics and how the scenario would arise given particular states of affairs. Sauropod gigantism, by contrast, is an exquisite corpse: birds provide a model for respiratory systems; giraffes, swans and structural morphology tell us something about possible sauropod stances; elephants and large lizards about possible metabolism. There is no single unifying regularity which can be appealed to. In explaining gigantism, I refer to particular facts about the sauropod lineage and the environment in which it evolved.

I have mentioned that some philosophers take narrative explanations as problematic insofar as they do not appeal to regularities, and that I will not take a stance on this here. With embeddedness on the table, I can clarify this. Clearly embedded explanations appeal to regularities: the interesting question is whether non-embedded explanations do, or must. I am inclined to see non-embedded explanations as leaning on a patchwork of regularities. For instance, models of structural morphology, population genetics and metabolism are all appealed to in explanations of sauropod gigantism. However, it is open for others to argue that such appeals are not always required.

Embeddedness, then, tells us whether an explanandum is accounted for as an instance of a general model, or as an individual event.

Simple & Complex

Call an explanation which is high in detail, and not embedded, a *complex narrative*. Call an explanation with is low in detail and embedded a *simple narrative*. Complex and simple narratives are two distinct explanatory strategies employed by historical scientists.

To drive the distinction home, compare the explanation of gigantism in sauropods to cases of island gigantism. The six-foot, tree climbing, predatory Fossa of Madagascar, for instance, evolved from much smaller mongoose-like ancestors. Because islands are isolated and tend to lack diversity, diminutive lineages are likely to form founder populations and radiate into unusual niches. This can lead to island gigantism: a lack of predation, and selection pressure to fill empty niches, drives size increase. The Fossa are gigantic because the isolation of Madagascar set up the preconditions for island gigantism. Fossa are amenable to a simple explanation: embedded in general explanations of island biogeography and requiring minimal detail. To explain fossa gigantism, I need only explain the general model of island gigantism, and then show how fossa met the model's conditions for evolving large size. Sauropod gigantism, by contrast, begs a complex explanation: more detail is required and there is no general regularity to subsume the explanandum.

Detail and embeddedness come apart in principle, but in practice tend to be coupled. Embedded explanations tend to be low in detail as explanatory sufficiency is determined by the strictures of the model. To get the Snowball Earth explanation, I show that the antecedent conditions of the model were met – and this only requires reference to causal factors from that model. This allows many causal details to be ignored, making for a low-detail explanation. Non-embedded explanations tend to require more detail as they cannot rely on general regularities to discount causal factors. In the Sauropod case, we require separate convincing of each step in the explanation. There may be cases of embedded, high detail explanations as well as low detail, unembedded explanations, but these are rare.

A *simple* narrative explanation, then, does not require a detailed treatment as the explanandum is represented in a general model. A *complex* narrative requires specific details unique to the case at hand and is not subsumed under a particular model.

This distinction is important. First, it explains two divergent approaches to understanding the explanatory unity of narratives. In Hull's treatments (1975, 1989) narrative explanations owe their unity in part to the integrity of the *historical entity* they target. "The role of the central subject is to form the main strand around which the historical narrative is woven (255)." According to Hull, accounts of sauropod gigantism and snowball earth are explanatory in virtue of picking out central subjects (spatio-temporally distended objects), and providing a coherent narrative about that subject.

By contrast, Glennan (2010) argues that narrative explanations operate through *ephemeral mechanisms.* By his lights, historical scientists explain states of affairs by showing that the preconditions for a general mechanism are in place. Such mechanisms are unusual due to their contingent (hence 'ephemeral') nature, but still deliver robust results *given* that arrangement. The characteristics of early sauropods, or the continental arrangement of the Neoproterozoic, are highly contingent states of affairs. But *given* those states of affairs, we get general results: gigantism and a general freeze (see Gallie 1959 for a similar view).

For Hull then, part of a narrative's explanatory unity is due to their central subject. For Glennan, unity is owed to regularities. This disagreement is resolved when we see that narrative explanations take two different forms. In simple cases, historical scientists appeal to general models which subsume the target case as Glennan envisions. In complex cases, explanatory force might be supplied by historical entities as Hull sees it.

Second, the distinction shows that historical scientists are not unified in their approach to explanation. They pursue two distinct strategies which require separate philosophical treatments. I illustrate this in reference to mechanistic explanation. It turns out that simple narratives can receive a mechanistic gloss, while some complex narratives are not mechanistic. Showing this is the task of the second half of the paper.

2. Mechanistic explanation

Mechanistic explanation has proven an illuminating account of actual scientific practice (see Bechtel & Richardson 1993, Glennan 2002, Craver 2007, Woodward 2002, Machamer, Darden et al 2000) In this section I sketch the account, then discuss how it may be extended to cover population-level explanation. Discussing narrative explanation in the context of mechanistic explanation will show that 1) simple narrative explanations are unified with population-level explanations (but not with complex narrative explanations) and 2) not all scientific explanations are mechanistic (as some complex narratives are not).

There are reasons to compare mechanistic and narrative explanation. First, there is a tension between historical explanation and models of explanations referring to hierarchical structure, such as reduction. Traditional models of reduction require explanation to refer to general laws which are realized at 'more fundamental' levels of description than the explanandum. Such laws are not overtly appealed to in historical explanation. Mechanistic explanation is intended to replace reductive models (Craver 2005, Bechtel & Abrahamsen 2005), retaining their advantages but avoiding imperialistic and nomological pitfalls. If mechanistic explanation is such a replacement, we might wonder whether the tension between historical and structural explanation is retained.

Second, as 2.2 covers, there is interest in the limits of mechanistic explanation. Is mechanistic explanation a general account of scientific explanation, or is it one of many explanatory strategies scientists might follow?

As we shall see, the tension between historical and structural explanation is retained in some complex narratives. In such cases scientists do not attempt mechanistic explanations because the unembedded, high-detail nature of the explanation undermines the utility of a mechanistic approach. And for the same reason mechanistic explanation has limited scope: scientists are not just in the mechanism business, sometimes they are in the complex narrative business.

Third, understanding the nature of historical explanation is a worthy philosophical task and its relationship to mechanistic accounts is illuminating. I have already shown that narrative explanation is disjunctive between simple and complex strategies. As we shall see, simple narratives are unified with population-level explanations via their common 'mechanistic' nature, while complex narratives are the odd ones out.

2.1 A sketch

In this section I aim to provide a minimal set of conditions required for any explanation to be presented mechanistically. In explaining a mechanism I must identify the phenomenon I am concerned with, break it into components, and explain the phenomenon's behavior in terms of the causal and organizational properties of the components. For the purposes of this paper, I will take an explanation to be mechanistic if it meets the following criteria:

1) *Localization*: the phenomenon is a discrete system with discrete components

2) *Constitution*: systems are constitutively explained in terms of components

3) *Nested Causation*: behaviors of systems are explained in terms of the causal and relational properties of components

This sketch is certainly not exhaustive of all that is important and distinctive about mechanistic explanation. However, it is a minimal set of conditions which I hope mechanists of all stripes would agree with and are all I need for present purposes. It is clear that more needs to be said about localization: what is meant by 'discrete', and how does it restrict the scope of mechanistic explanations? I will put this question aside until 2.2.

Many sciences are characteristically mechanistic. Cytologists understand cells as discrete parcels composed of a cellular anatomy which determines behavior. Neuroscientists identify neural networks as systems fulfilling particular functions governed by activation patterns within them. Molecular geneticists identify genes with particular DNA sequences which code for proteins given the right inputs and organization. Chemists explain phase-transitions as the result of the interaction between kinetic energy and chemical bonds in a system. All follow mechanistic explanation's distinctive pattern.

However, some scientific endeavors look different. Ecologists, economists and evolutionary biologists use abstract models to explain the behavior of populations. Paleontologists, geologists and archaeologists construct narrative explanations of events in the deep past. Using abstract models to explain population-level phenomena and using causal sequences to explain past states of affairs appear very different from the explanations mechanists examine. In the next section, we see whether mechanistic explanation can account for these as well.

2.2 'Liberalism' about mechanistic explanation

Consider two views on the scope of mechanistic explanation. By a *conservative* view the model has thin scope - it is true of some, but not all, scientific explanations. A *liberal* view takes the model to have wide scope – most, perhaps all, scientific explanations are mechanistic. Liberalism involves showing that various explanatory schema are subsumed by mechanistic accounts, and this may involve tweaking the conditions sketched above.

Let's start with two examples. Bechtel (2011) argues that mechanistic explanation must include dynamic causal streams to capture biological phenomena which display non-linear behavior, such as cellular self-repair. It is not obvious that mechanists ever intended their models to be rigidly linear, and moreover expanding the account to include dynamic mechanisms doesn't seem to conflict with anything essential to the sketch above. By contrast, Rusanen and Lappi (2007) argue that some cognitive phenomena are beyond the scope of mechanistic models as they require top-down explanation. This clashes with constitution: instead of the phenomenon being explained in terms of its parts, the parts are explained via the phenomenon. If they are right, mechanists have a choice between the conservative move of taking some cognitive explanations non-mechanistically, or the liberal move of altering the requirement of constitution. Some cases, then, are more or less challenging to the model.

A liberal move pertinent to comparing narrative and mechanistic explanation is discussed by Matthewson & Calcott (2011). They argue that explanations of population-level phenomena, such as market cycles and predator/prey dynamics, can be understood mechanistically. I argue that simple narrative explanations can be understood in the same way.

Matthewson & Calcott distinguish between *mechanisms* and *mechanistic models*. A mechanism is a concrete object with localizable, discrete components. A mechanistic model takes the *structure* of mechanistic explanation and applies it to non-mechanisms. It is not clear whether economies, ecologies or cities are mechanisms, but we may successfully explain them *as if they were*. In explaining their target, modelers entertain the fiction (Godfrey-Smith 2009) or the idealization (Weisberg 2007) that it is a mechanism, enabling them to employ mechanistic explanation.

Take an evolutionary explanation of a shift in the proportion of some trait, *t*, in a population across two subsequent generations, G_1 and G_2. In G_1 *t* is less common than it is in G_2. To explain this change, a biologist might refer to a model which considers the population in terms of various traits with various fitness-values. The makeup of the population at one generation is determined by the fitness values of the traits present in the generation before. Because of *t*'s fitness value, it outperformed some other traits in reproducing between G_1 and G_2 and was thus more common in the later generation. Whether this is a mechanistic explanation depends upon its interaction with the conditions I outlined above.

The explanation is mechanistic, with a tweak. First, it involves decomposition: the population is understood as comprising either individuals or traits with fitness-values. Second, it involves nested causation[4]: the change between the two generations is explained as the result of the interacting fitness

[4] This example is meant to be illustrative, and skates over some difficult issues in biology. Some philosophers (Walsh, Lewens & Arieu 2002; Walsh 2010) deny that fitness is truly causal, insisting that only the particular life-events of individuals in the population are the proper locus of causal power – and thus calling this 'nested causation' is a mistake. Fair enough, but I think this perspective is in fact amenable to the story I am telling. First,

values of the components. However, the phenomenon does not appear to be a discrete system. Few real-world biological populations have discrete, non-overlapping generations and even fewer have populations as discrete as the model represents. And yet the system is treated *as if* it were a discrete, localizable system. Matthewson & Calcott can retain the first tenet by allowing for idealized, or metaphorical localization. Something like:

> *Localization**: the phenomena either is a discrete system, or may be *treated like* a discrete system

Until now I have avoided explicit discussion of what is meant by 'discreteness', but it is time to draw this out. A discrete system is not necessarily such in virtue of spatio-temporal location, but rather the *causal integration* of its parts. It has discrete components insofar as they are *modular*: they perform particular, identifiable and perhaps extractable functions in the context of that system (this account is meant to be broadly aligned with Wimsatt's (2007)). A clockwork machine can be a paradigmatically discrete system. It is discrete in terms of causal integration: the behaviors of clockwork (keeping time, say) depend upon the interaction of a specific set of contained parts. Moreover, the components are modular: the various cogs and wheels can be removed from the system and play identifiable roles within it. When Matthewson & Calcott argue that population-level explanations are capturable by mechanistic models, they simply idealize from a paradigmatically discrete system, to a less clear case.

'Discreteness', as I understand it, is clearly graded; and this should make *localization** unproblematic for mechanists – most accounts of mechanistic explanation already commit to something like this. Indeed, discussion of mechanistic explanation is rife with discussion of idealization. And so a clockwork machine is quite discrete. A neural network is less so: although neuroscientists individuate networks via examining neuroanatomy and firing patterns, complex overlapping and interrelation exists between the entities in the system. The more the example diverges from an ideally discrete system, the more metaphorical in character the mechanistic explanation of it becomes. This has consequences for the process of localization applied in different cases. For more 'machine-like' cases, such as clockwork, we

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one might claim that non-causal factors are here presented *as if* they were causal, and so 'nested causation' is, like localization, receiving a fictionalist treatment. Second, one could claim that 'fitness' in the this context is merely a term of art meant to unite whatever truly causal factors in fact lead to the births and deaths which occur within the population. Moreover, the main concern of such philosophers is whether explanations appealing to fitness should be read as *mathematical* explanations – and discussion of the relationship between mathematical and mechanistic explanations is beyond the scope of this essay.

are more able to ‘read’ the system from the world. The components of the mechanistic model map onto components in the world. In less ‘machine-like’ cases, a process of simplification, abstraction or idealization is required. The ‘fitness value’ of some trait, for instance, does not obviously (if at all) map onto components in the real world system. They rather pick out explanatorily salient features of the target. Representing population-level phenomena as discrete systems requires that we ignore certain causal factors. This is not, of course, an original claim – indeed I think it is necessary for understanding mechanistic explanations, but it is worth restating for as we shall see, although such idealizations occur in simple narrative explanations, they do not in many complex cases.

And so Matthewson & Calcott are able to present many of the explanations in population-level science as mechanistic insofar as they accept a ‘fictionalist’ turn in localization. Given that many paradigm examples of mechanistic explanation (neural networks, gene sequences) are themselves only ideally discrete this change is not too problematic. However, the process of localization changes depending on the discreteness of the system: for characteristically mechanistic phenomena the system can be ‘read off’ the world, for other cases a process of simplification is required. The final section brings this liberal account of mechanistic explanation together with narrative explanation.

3. Mechanistic Narratives?

Let’s take stock. Narrative explanations, which explain individual events via causal sequences, take two distinct strategies:

Simple narratives, which 1) explain an event as a state of a general model, 2) contain minimal detail;

Complex narratives, which 1) explain the event via a unique causal sequence, 2) are highly detailed.

To be mechanistic, an explanation must meet three criteria: *localization*, *constitution* and *nested causation.* Via a fictionalist tweak to localization, population-level explanations can be seen as mechanistic.

This section argues that 1) simple narrative explanations are mechanistic in the same sense as population-level explanations as they are an instance of the same explanatory strategy; 2) some complex narratives are not mechanistic. The upshot of these two points is that liberalism about mechanisms is restricted (as there are scientific explanations which are not mechanistic) and that simple narratives have more in common with non-historical explanations (such as those from economics, sociology and ecology) than complex narratives.

3.1 Simple Narratives as Mechanistic Models

Population-level explanations and simple narrative explanations are unified. The economist treats real world markets as if they were discrete mechanisms, the evolutionary biologist imagines an island eco-system as constituted by various ecological roles waiting to be filled by genealogical actors. My exemplar simple narrative, Snowball Earth, is also an exemplar mechanistic model.

An explanatory model is mechanistic when it meets the three criteria, with the fictionalist turn described in 2.2. The phenomenon must be treated as if it were a discrete system with discrete components. It must be described constitutively. Its behavior must be explained as the result of interactions between its components. Consider the explanation sketched in 1.1. Presumably the real-world interrelation between ice-cover, atmosphere and global temperatures are extremely complex. The explanation, however, is straightforward: paleoclimatologists are able to abstract from the details and present a simple model of the interactions. The highly interrelated, complex system is treated *as if* it were a simple, discrete system. Localization holds. This idealized system is constituted by various components, namely: global temperature, icepack cover, the locations of landmasses and global albedo. Constitution holds. And the system's behavior is ruled by the causal relationships between those components. As albedo increases and the atmosphere thins due to landmasses clustering around the equator, a feedback involving decreasing temperature, increasing ice cover, and increasing albedo leads to a snowball earth scenario. Nested causation holds.

Although simple narratives and population-level models are both instances of the same explanatory strategy, it does not follow that scientists concerned with discovering historical facts face identical epistemic challenges, or use the same methods, as sciences concerned with population-level facts. It may be that ecologists and economists employ the modeler's strategy to deal with the over-abundance of facts pertaining to their explananda, while historical scientists use it to gain access to the scarcity of traces available from the past. My point is about the unity of explanatory strategies.

3.2 Complex Narratives are not Mechanistic

Scientists providing complex narratives do not attempt to embed their explanations in an overarching system, but rather provide a causal sequence which reasonably leads to the state of affairs in question. Typically, scientists providing complex narratives do not describe a localized system and do not take the explanans as system-components. They are not mechanistic.

Sauropod gigantism could in principle be explained via a 'gigantism mechanism' whereby a diminutive lineage is fed into a massively complicated idealized machine, outputted as giants millions of years later. But scientists do not explain them in those terms. Rather the history of a particular lineage is explained in reference to various causal factors interacting with it. Geologists explain Snowball Earth by representing the target as a mechanistic model. It is simplified to a localized system. There is less simplification in the sauropod case: scientists do not see the lineage as a system. After all, what would such a system look like? The explanans paleobiologists appeal to are at many temporary and hierarchical grains, and it is not obvious whether such a disparate group is amenable to unified representation. Moreover, there is a difference between a unified model and a conjunction of different (perhaps incommensurable) models. Explanans are not 'components' but rather causal factors which influenced the particular pathway the lineage took.

The point is this: even if the explanation can be described in mechanistic terms, that is not the explanation's form.

Why not? The process of localization is opaque for complex narratives due to a tension between providing a simple, tractable model and meeting the high-detail requirements of the explanation. Mechanistic approaches are attractive when the world cooperates: either the explanandum is a discrete, decomposable system or it is simple and unified enough to be helpfully treated as such. In at least some complex narratives, the requirement for high detail and the unavailability of a general regularity conspire to undermine the utility of a mechanistic conception.

Historical scientists, then, are not always mechanists. Faced with a complex, messy world they sometimes respond with complex, messy explanations.

Conclusion

I have argued that historical scientists follow two distinct explanatory strategies. Simple narratives typically idealize and abstract away from their target and are amenable to a mechanistic gloss. Complex narratives are different: some do not admit of mechanistic treatments. When providing complex narratives, historical scientists are not mechanists. This points to a host of new questions. Are there situations when simple or complex approaches are more appropriate? I have suggested that the nature of explananda play an important role in applicability, but much more remains to be said. Ought we prefer simple or complex narratives? I have said nothing about the value such explanations have. I am inclined to think of the strategies as geared towards different explanatory interests and kinds of explananda, and so validity turns on context. However, the floor is still open for those who prefer one over the other. Historically philosophers have preferred the kind of unified explanations offered by simple narratives but in some cases complex narratives may be more testable. As Kim Sterelny has pointed out to me (personal communication), a detailed narrative will have more points of empirical contact with the world, and so may have more opportunities for testing.

Finally, do other sciences have similar divisions? I have presented a unified picture of some of the explanations furnished by ecologists and economists on the one hand, and paleontologists and geologists on the other. It will be interesting to see whether some population-level explanations diverge from this pattern, and whether other areas of science can be carved up along similar lines. Moreover, I have not claimed that narrative explanations are unique to historical science (although they may be paradigmatic of them), and an investigation into whether the distinction between complex and simple narratives is useful outside of that context is also in the offing.

Attending to the different strategies historical scientists employ in their explanations illuminates important philosophical issues, and helps us understand the nature of their work.

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