The Roles of Possibility and Mechanism in Narrative Explanation

Abstract

There is a fairly longstanding distinction between what are called the *ideographic* as opposed to *nomothetic* sciences. The nomothetic sciences, such as physics, offer explanations in terms of the laws and regular operations of nature. The ideographic sciences, such as natural history (or, more controversially, evolutionary biology), cast explanations in terms of narratives. This paper offers an account of what is involved in offering an explanatory narrative in the historical (ideographic) sciences. I argue that narrative explanations involve two chief components: a possibility space and an explanatory causal mechanism. The presence of a possibility space is a consequence of the fact that the presently available evidence underdetermines the true historical sequence from an epistemic perspective. But the addition of an explanatory causal mechanism gives us a reason to favor one causal history over another; that is, causal mechanisms enhance our epistemic position in the face of widespread underdetermination. This is in contrast to some recent work that has argued against the use of mechanisms in some narrative contexts. Indeed, I argue that an adequate causal mechanism is always involved in narrative explanation, or else we do not have an explanation at all.

1. Introduction

The historical sciences (geology, paleontology, evolutionary biology, etc.)[1] are usually thought to deploy different explanatory strategies than the non-historical sciences (Turner 2007; Turner 2013). Whereas physics, say, seeks explanations given in terms of general laws and the like, the historical sciences seek to explain in terms of narratives. In this paper I will argue for a version of narrative explanation involving two chief components: possibility spaces and causal mechanisms. It has recently been argued that complex historical narratives (to be defined later) can't support explanations involving causal mechanisms (Currie 2014). I argue that this is mistaken. I'll go over some recent work on the history of abiogenesis research to support this contention.

The argument presented in this paper will defend two primary claims: (1) the conceptual structure of narrative explanations nearly always involves a space of alternative possibilities. This can be for either epistemic or ontological reasons. From and epistemic perspective possibility spaces are necessary on account of our position relative to the available evidence. That is, the available evidence radically underdetermines any particular causal history, and on the basis of that fact many possible histories appear compatible with what we know (see Gordon and Olson 1994, p. 15). Construed ontologically, a set of historical facts might involve a high degree of objective contingency—it might be the case that things really could have gone a number of different ways. For the purposes of this paper I remain silent with respect to this ontological aspect and defend the importance of possibility spaces for largely epistemic reasons. (2) Adequate causal mechanisms enhance our epistemic position relative to alternative causal

[1] I note that the idea of evolutionary biology as a properly "historical science" is a controversial one. See Ereshefsky (1992) for some strong arguments against the idea of evolutionary biology as having a distinctively 'historical' flavor.

histories. Causal mechanisms put us in a position to better assess the plausibility of a given history within our possibility space, and in this way enhance the epistemic power of a purportedly explanatory historical narrative. This can involve either the actual discovery of such mechanisms, or raw theoretical innovation. Citing an adequate causal mechanism may not discriminate between possibilities in decisive fashion. Rampant underdetermination seems to rule out such a possibility (see Turner 2007). But an adequate mechanism does make a given explanation more explanatory than its competitors, and so part of the task is to see how this notion of mechanistic adequacy can be cashed out in such a way as to make this notion of *explanatoriness* epistemically significant and not simply *ad hoc*.

2. The Role of Possibility Spaces

In the introduction I said that I would defend two major claims: (1) the conceptual structure of narrative explanation nearly always involves a space of alternative possibilities, and (2) adequate causal mechanisms enhance our epistemic position relative to alternative causal histories. This section will address the first claim by giving a more detailed account of the conceptual structure of narrative explanations and why the role of possibility spaces is so central to them.

When confronted with a natural historical problem (e.g. accounting for the processes involved in the formation of atoll reefs, say (see Ghiselin 1969)) it is my claim that what we are confronted with is, in fact, a space of *possible* histories. That is, when the historical scientist attempts to answer the question, “What geological process accounts for the formation of atoll reefs?” she understands—perhaps implicitly—that there are a number of ways things *might* have gone: she sees many possible histories. This space of possible histories essentially generates a contrasting set of possible explanations, each possible history corresponding roughly to one hypothetical solution to the problem.[2] Obviously there's just one causal history that actually obtained, but the evidential situation is such that this history is not uniquely fixed from an epistemic perspective (see Roth 2017). The historical scientist's explanatory task then consists in finding the best approximation of the true causal history.

A nice example of this sort of reasoning process can be glimpsed in the debates over speciation processes among evolutionary biologists and paleobiologists. Stephen J. Gould and Niles Eldredge (1972) developed the theory of *punctuated equilibria* to account for the pattern of speciation witnessed in the fossil record. The idea of punctuated equilibria, in brief, holds that evolutionary change occurs in sudden bursts (on geological timescales, anyway), followed by long periods of relative evolutionary stasis. The going theory of evolutionary change at the time held to *phyletic gradualism*—the idea that the pace of evolution is slow and relatively uniform (see Turner 2011). Each of these alternatives is broadly consistent with the available fossil evidence. Phyletic gradualism takes the view that the evolutionary process is gradual, and that the fossil record is very patchy. The putatively patchy character of the fossil record means that we shouldn't expect to be able to use it as a tool for faithfully reading off patterns of speciation in the actual history of life. The theory of punctuated equilibria has it that the fossil record is relatively faithful to evolutionary history, meaning that the fossil record *does* have some explanatory import with respect to uncovering important evolutionary patterns (like speciation). The evidence in the fossil record can support either interpretation.

Consider another example, this time from geology. 19th century geologists were confronted with a fascinating geological puzzle involving what were called 'erratic blocks'.

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[2] I'm certainly *not* claiming that the historical scientist is in a position to generate or realize all possible histories, as the number of such alternatives is plausibly infinite. But certainly it's possible to generate quite a few, and it seems that in fact we usually do.

These hulking slabs of (usually) granite are found miles away from any related rocks, and so the obvious question to be answered is, "How did such a large piece of granite come to be deposited here?" In 1820s Europe the answer was not immediately obvious. One well-documented case involved a granite erratic in Switzerland, which was determined to be composed of primary rocks of Alpine origin, but resting on a limestone formation many hundreds of miles from any mountains (see Rudwick 2014, pp. 117-25). Several explanations were offered: that it was deposited by the waters of the Noahic deluge; that it was carried and deposited by waters traveling down the Alps from a broken mountain dam; and only later that it was carried by glacial ice and then deposited after a subsequent melt. The process of adjudicating between each such purportedly explanatory histories (whether evolutionary patterns or seemingly bizarre geological deposits) is the subject of the next section.

It's important to stress that the evidential underdetermination of historical hypotheses is quite different than underdetermination in science more broadly. Turner (2007) argues convincingly that the problem of underdetermination is rather severe in the historical sciences given that natural processes actively destroy the evidential traces on which historical scientists rely.[3] There are two points that make this worthy of note. First, it is precisely for this reason that the explanatory task of the historical scientist *necessarily* involves the generation of a possibility space. If we can think of a natural history as a story concerning the artifacts of the natural world, then what the world presents us with is a story that's missing a great many pages. The unfortunate fact of the matter is that there are many ways of filling those pages in, each of which

[3] Turner appeals to the role played by background theories in the historical sciences to motivate his point. Here, there relevant theory is *taphonomy*, which describes the mechanisms by which the relevant evidence is destroyed (remineralization, decomposition, etc.).

is broadly compatible with our evidential situation.[4] Second, widespread underdetermination is what motivates the earlier insight that the explanatory aspiration of historical science is to give the best *approximation* of the true causal history. It is implausible to think that any of the historical hypotheses we generate will fill in the missing pages perfectly, but we can have reasons to think that some hypotheses outperform others (of which more to come).

To summarize, possibility spaces are ineliminable from narrative explanations because of our epistemic position relative to the evidence at hand. What we want is to develop a causal history that explains the phenomenon in question (e.g. erratic blocks and evolutionary patterns), but right away we realize that many different and mutually incompatible histories could—hypothetically—do the trick. The construction of a space of live possibilities allows us to have some degree of confidence that we've explored the relevant alternatives.[5] Once we've developed a space of possibilities, the initial question (such as, "What accounts for the formation of atoll reefs?") becomes importantly *contrastive*: "Why *x* and not *x'*?" where *x* and *x'* are alternative possible causal histories accounting for the target phenomenon. We want to know how it is that possibilities come to be "foreclosed" upon as a narrative explanation develops, as Beatty (2016) puts it.

3. Causal Mechanisms and Hypothesis Adjudication

[4] See Turner (2011) chapter 2 for more in-depth discussion.
[5] There's a way of reading this that might tempt one to see this as something akin to *inference to the best explanation*. Any such connection is largely superficial. The primary reason for this is that the explanatory scheme that I'm outlining is not meant to be making any especially strong claims about the strength of an explanation as related to its connection to reality. Perhaps none of the causal histories we generate are very accurate as descriptions of the true causal history.

I now turn my attention to an explication and defense of (2): adequate causal mechanisms enhance our epistemic position relative to alternative causal histories. Causal mechanisms are what provide reasons for preferring one possible causal history over another as regards the space of possible histories generated by the natural historical problem at hand.

3.1. Mechanistic set-ups-

Because contingency is generally seen as playing such a fundamental role in natural historical contexts, the relevant mechanisms are not likely to be cashed out in terms of ‘invariances’ and ‘regularities,’ as is common in other scientific contexts (see Havstad 2011; Darden and Craver 2002). For the purposes of natural history we might instead think in terms of a more minimal conception of causal mechanisms that I’ll call *mechanistic set-ups*. A mechanistic set-up differs from paradigmatic mechanisms (as in Glennan (2002))[6] in that it will often be the case that mechanistic set-ups are the result of one-off circumstances. Paradigmatic mechanisms characterize causal systems that are largely stable across time (think of protein synthesis, for instance). Mechanistic set-ups are not stable across time in this way, but still render outcomes causally expectable given that the right antecedent conditions obtain. That is, given that the right antecedent conditions obtain (and this may, of course, be a *highly contingent* affair), the causal output of the system is fully determined—we have a case of mechanical causal output.

Nancy Cartwright and John Pemberton (2013) give a simple example of a mechanistic set-up using a toy sailboat. When the toy boat is placed in the water it displaces enough liquid to

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[6] “A mechanism for a behavior is a complex system that produces that behavior by the interaction of a number of parts, where the interactions between parts can be characterized by direct, invariant, change-relating generalizations.”

stay afloat; it has a wind-catching device for locomotion; the wind-catching device is acted about by wind gusts in order to achieve locomotive action. If we take this example as having to do with the actions of an *agent* that brings about the mechanistic set-up then we might incline toward an interpretation of the situation in terms of paradigmatic mechanisms. But imagine there's no agent involved at all; that is, let it be the case that nobody placed the boat on the water, and likewise nobody chose any windy day in particular for the use of the boat. Instead suppose that it is a series of contingent events (a child threw the boat in the garbage, it fell out of the garbage truck on the highway, and is now on the surface of a local pond, etc.) that have made things such that the boat is at some later time moving across the top of the water in the expected way.

The one-offness of the circumstances in the revised toy boat example doesn't seem to make the situation non-mechanistic in character. Rather, the mechanism just isn't stable across time in the same way paradigmatic mechanisms are. This is a mechanism in a more minimal sense: it is a mechanistic set-up. In other words, the realization of appropriate antecedent conditions renders the outcome causally expectable, even though the antecedent conditions are highly contingent.[7]

This case is so simple that it won't have much bite against Currie. Recall that Currie's claim is that mechanisms show to be of no use in *complex* narratives. In these cases the explanatory targets are *diffuse*, meaning that they involve complex networks of causal contributors (Currie 2014). An example of a diffuse target is Sauropod gigantism, Gigantism involves, at least, skeletal pneumatization, ovipary, increased basal metabolic rate, etc. Nothing seems to unify such causal contributions, and so there is no *mechanism* for gigantism, according to Currie—the explanatory target is *too diffuse* in complex narratives.

[7] See chapter 3 of Conway Morris (2003) for an in-depth discussion.

3.2. Abiogenesis, mechanistic set-ups, and hypothesis adjudication-

Abiogenesis, I argue, qualifies as a minimal mechanistic set-up in the sense just argued for. That is, the set of facts that determined the development of the very first self-replicating, heterotrophic organisms are plausibly subject to a high degree of contingency (see Conway Morris 2003), but even so, life is a deterministic consequence of just such a contingent set of facts.[8] Further, the instances that the theory aims to explain (e.g. self-replicating molecular systems; heterotrophic metabolic systems; protective membrane enclosures, etc.) are diffuse in the same sense as Sauropod gigantism. My aim here is not to give a full theoretical survey of abiogenesis, but instead to provide just enough content to justify the claim that work in this area fulfills the description of narrative already given, and that causal mechanisms play an important explanatory role, specifically to do with hypothesis adjudication.

Probably the first serious theoretical work on the origins of life is A.I. Oparin's 1923 *The Origins of Life* (Falk and Lazcano 2012). The basic theoretical framework is familiarly Darwinian. Oparin had in mind a model of biological origins whereby life comes on-line in stages, rather than all at once. The prebiotic world, on this view, was one of something approximating 'molecular competition.' For Oparin this amounted to chemical assemblages witnessing differential stability, approximately underwriting a growth model of molecular evolution (Falk and Lazcano 2012; Pigliucci 1999). The primary thing to be explained, on this model, was the development of heterotrophic metabolism. Metabolic pathways are so complex

[8] Some recent work in origins of life research may end up giving reasons to question the assumed contingency of life's emergence. See Kauffman (1993) for a classic treatment of the "self-organization" thesis, and England (2015) for more recent theoretical developments.

that Oparin thought their development must be accounted for in a basically stepwise fashion. Differential stabilities of chemical assemblages would make it such that certain molecules would make up increasingly large proportions of the chemical ‘population,’ making them live candidates for further downstream innovation (like complex metabolic pathways).

Oparin-type selection models have mostly—though perhaps not entirely—fallen by the wayside. Contemporary work is focused primarily on accounting for the possibility of self-replication and autocatalysis (Penny 2005). The thought is that biological origins must be accounted for in something like a two-step process, one involving the development of self-replicating material suitable for hereditary mechanisms, and another for things like metabolism and heterocatalytic functions like protein construction (Falk and Lazcano 2012; Conway Morris 2003). One of the more promising research strains in this area concerns what’s known as the ‘RNA World’ (Conway Morris 2003). It’s widely believed to be the case that the first replicators were RNA (or RNA-like) molecules. So, RNA World researchers are attempting to simulate the conditions of the prebiotic Earth in the laboratory in order to see whether the RNA model of biological origins can carry its empirical weight.

Of note for the purposes of this paper is that the dispute between metabolism-first and replication-first models of abiogenesis is precisely over whether the causal mechanisms in play can adequately account for the target phenomenon: namely, the development of living organisms in the ancient history of Earth. H.J. Muller developed a theoretical agenda stressing the need for self-replicators at the historical foundations of life (Falk and Lazcano 2012). Oparin took heterotrophic metabolic pathways as the primary puzzle to be solved (Oparin 1938; Falk and Lazcano 2012). The replication-first view has emerged as the going view among contemporary researchers primarily because it offers a more plausible mechanism for life’s early development.

In order to build complex metabolic pathway it seems like it's first necessary to have a genome space that's large enough to enable downstream innovation of complex functions. So it is that the replication-first view and the research agenda dictated by projects like RNA World are taken to be more explanatory than Oparin-type explanations given in terms of selection among molecular assemblages.

4. Putting Things Together

Let's recall once more the two key claims being advanced: (1) the conceptual structure of narrative explanation nearly always involves a space of alternative possibilities, and (2) adequate causal mechanisms enhance our epistemic position relative to alternative causal histories. Widespread underdetermination in the historical sciences leads to the persistent appearance of possibility spaces as specified by (1), and the development of adequate causal mechanisms specified under (2) enhances our ability to adjudicate the alternatives we're faced with. Causal mechanisms put us in a position to address the contrastive question, "Why *x* and not *x'*?" Causal mechanisms are the devices by which historical counterfactuals become foreclosed upon in the sense of Beatty (2016).

Because explanation in the historical sciences is contrastive in the above sense, I argue that some notion of mechanism is involved in *every* case of successful narrative explanation. Currie (2014) argues that causal mechanisms are appropriate only for the purposes of simple narratives apt to be embedded in terms of regularities. Complex narratives with their diffuse explanatory targets require something more piecemeal that doesn't count as a causal mechanism. My more minimal conception of causal mechanisms given in terms of *mechanistic set-ups* sheds light on why this can't be right. Mechanistic set-ups aren't stable across time like paradigmatic mechanisms, and yet we have good reason to think that the consequences of such set-ups are mechanistically determined (see Penny 2005; Glennan 2010).[9] It is just this sort of conception of mechanism that helps us to make sense of explanatory success in abiogenesis (such as it is).

Surely the genesis of the first biotic creatures is every bit as diffuse an explanatory target as Sauropod gigantism. I've argued (and I think convincingly) that it is precisely due to the adequacy of some underlying mechanism that one explanatory agenda in abiogenesis has been accepted over the alternatives. The complexity of the narrative and the diffuseness of the explanatory target appear to be beside the point. Without an adequate mechanism—however minimally construed—we can't answer the contrastive question, and so we have no explanation at all.

5. Objection and a Reply

According to Currie (2014) mechanistic set-ups (*ephemeral mechanisms* (Glennan 2010)) look like they're simply pointing to claims about sensitivity to initial conditions. If that's right, then there's a problem, because causal processes in natural historical contexts are often thought to be contingent not just in the sense that they display sensitivity to initial conditions. Such processes are taken to be subject to contingencies in a more robust sense involving "causal cascades" themselves (Currie 2014). It is not unreasonable, for instance, to think that whether a chemical assemblage will manage to hit the right configuration and produce a self-replicating RNA strand is not just a matter of realizing the right set-up conditions (independent of the chances of hitting

[9] Penny notes some interesting experimental results in which living organisms are frozen to near absolute zero, meaning that all information concerning the positions and velocities of the particles in their make-up is lost. They can, nonetheless, be successfully reanimated. Given that the only information that's retained after such a deep freezing involves the chemical structure of the organisms, a natural inference is that 'life' is a mechanical consequence of chemical parts.

on such a configuration). Whether the chemical elements enter into the appropriate causal relations for manifesting autocatalysis might *itself* be a probabilistic matter. Having the right elements might not be all you need—you might need the right elements plus a bit of probabilistic luck. Objective probabilities of this sort might do some damage to the mechanistic account, since it would seem not to be the case that an explanandum *just follows* from a causal set-up. The force of this objection is at least partly dependent on one's answer to the question of where in the world we ought to 'place' objective chances (if there are any).

Most of our intuitions about objective probabilities (probably) derive from our ongoing observations of the world. A lot of stuff in the world *just seems* chancy. We regularly speak in terms of the "odds" or "chances" of developing cancer and the like. Simplifying quite a bit, when we say that there's a 40 percent chance that Susan will live for more than 5 years after being diagnosed with some cancer that has developed to some particular stage, what we're saying is that approximately 40 percent of people that present as cases sufficiently similar to Susan have lived for 5 years or more. One way to read this is in terms of causal indeterminacy. That is, there is really no matter of the fact at time *t* as to what will be the case at time *t'*, aside from the probabilistic facts about cancer populations. The future is (to some degree) causally open, as the causal cascades are operating in a fundamentally probabilistic way.

Such a reading, however, is by no means forced. Bruce Glymour (1998) offers a picture wherein objective probabilities are placed at the level of causal *interactions*. That is, entities *e* and *e** enter into causal interactions with each other on a probabilistic basis, but when they do, the downstream effects unfold in a fully deterministic fashion. Probabilistic partitions of the world, then, are just reflections of whether certain causal interactions became manifest in certain subpopulations or not. If 40 percent of patients with a certain cancer at a particular stage will survive for more than five year, it's because free radicals (probabilistically) failed to enter into certain causal interactions with healthy cells. The opposite is the case for the contrasting class of fatal cases. On this picture, determinism of the relevant kind seems to be preserved. In such cases as the right causal interactions are realized, downstream effects unfold in mechanical fashion.

6. Conclusion

In this paper I argued for two main claims: (1) the conceptual structure of narrative explanation nearly always involves a space of alternative possibilities, and (2) adequate causal mechanisms enhance our epistemic position relative to alternative causal histories. The reason that narrative explanations involve possibility spaces has to do with our epistemic position relative to the available evidence. Undetermination so permeates the historical sciences that any problem for which we seek an explanation will involve an array of possible alternative causal histories, each of which is broadly consistent with the available evidence. It is the introduction of an adequate causal mechanism that puts us in a position to improve our epistemic lot—with a good mechanism in hand, we can begin to foreclose upon alternatives.

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