

## **Three conceptions of explaining how possibly—and one reductive account**

Philosophers of science have often favoured reductive approaches to how-possibly explanation. This article identifies three varieties of how-possibly explanation and, in so doing, helps to show that this form of explanation is a rich and interesting phenomenon in its own right.

The first variety approaches “How is it possible that X?” by showing that, despite appearances, X is not ruled out by what was believed prior to X. This can sometimes be achieved by removing misunderstandings about the implications of one’s belief system (prior to observing X), but more often than not it involves a modification of this belief system so that one’s acceptance of X does not generate a contradiction.

The second variety of how-possibly explanation offers a potential how-explanation of X; it is usually followed by a range of further potential how-explanations of the same phenomenon. In recent literature the factual claims implied by this sort of how-possibly explanation have been downplayed, whereas the heuristic role of mapping the space of conceptual possibilities has been emphasized. Below I will focus especially on this truth-bracketing sense of potentiality when I look at this variety of explanation more closely.

The third variety of how-possibly explanation has attracted less interest. It presents a partial how-explanation of X, and typically it aims to establish the existence of a mechanism by which X could be, and was, generated without filling in all the details. It stands out as the natural alternative for advocates of ontic how-possibly explanation.

This article translates divisions like those evident in Salmon’s (1984) view that explanation-concepts can be broadly divided into epistemic, modal, and ontic across to the context of how-possibly explanations. Moreover, it is argued that each of the three varieties of how-possibly explanation mentioned above has a place in science. That this is so may be especially interesting to philosophers: we are often misled by the promises made on behalf of various why-explanation accounts, and seem to have forgotten nearly everything about the fruitful diversity of how-possibly explanations.

## 1. Dray-Hempel: from epistemic conflict to consistency

Hempel (1970) offers an account of how-possibly explanation in two steps. These are best distinguished.<sup>1</sup> The first step builds on Dray (1957) and his observation about the contexts in which we require how-possibly explanations:

[T]he demand for explanation is, in some contexts, satisfactorily met if what happened is merely shown to have been *possible*; there is no need to go on to show that it was necessary as well. To put the point another way, I shall argue that although, as Professor Toulmin puts it, to explain a thing is often to “show that it might have been expected”, the appropriate criterion for [how-possibly explanations] is broader than this; for to explain a thing is sometimes merely to show that it need not have caused surprise. (Dray 1957, 157)

Dray emphasizes the element of surprise. He even claims that it is an essential feature of how-possibly explanation that it is given “in the face of a certain sort of puzzlement” (Dray 1957, 165). In fact, though, this first variety of explanation can be characterized independently of its psychological features. The need for how-possibly explanations arises when the explanandum, X, is, or seems to be, ruled out by the corpus of theories and empirical assumptions relied on in the explanans context (or “system” as I will occasionally refer to it) prior to X. The felt need for many explanations—including why-explanations—is prompted by the belief that X should not have happened; but in this case it is, or seems, impossible to add X to the system; it is this that is characteristic of how-possibly explanations:

[...] some of the beliefs we hold concerning relevant matters of fact seem to us to make it impossible or at least highly improbable that X should have occurred (Hempel 1970, 428).

As a consequence the process of finding explanans stops as it were before it has started.

With the exception of the belief in X itself, this variety of how-possibly explanation does not require evidence-gathering of the sort that favours new explanatory pieces of belief about the world. What is needed is either a correction of one’s perceptions of what the system is in fact consistent with or, more often, a withdrawal of those elements in the system that would lead to a contradiction if a belief in the explanandum phenomenon were added. Note that this variety of how-possibly explanation is alone, among those discussed here, in focusing on the acceptability of the *explanandum* itself.

As has already been mentioned, Hempel goes on to add a second step to his account of how-possibly explanation. But what we have already is in line with Hempel’s idea that successful explanations show that the explanandum phenomenon was in fact to be expected. Once conflicting beliefs have been removed, the non-occurrence of X is no longer to be expected—at least, not to the previous degree.

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<sup>1</sup> Already the first step captures a distinct notion, whereas the second step is reductive.

## 1.1 Illustration: The plankton paradox

Dray-Hempel how-possibly explanation seems to describe the relevant scientific contexts well enough. One case in point is what Hutchinson (1961) labelled *the paradox of the plankton*. Here findings indicated that, particularly in the summer, natural waters developed “striking” nutrient deficiency. According to the principle of competitive exclusion (Hardin 1960), we would expect one species to outcompete the others under these conditions, “so that in a final equilibrium situation the assemblage would reduce to a population of a single species” (Hutchinson 1961, 137). However, during the summer period a number of species of plankton are known to coexist.

The paradoxical character of this situation is evident. On the one hand, the principle of competitive exclusion was supposed not only to be strongly corroborated but even analytically true; on the other, it seemed to be an inescapable empirical fact that the principle delivered the wrong prediction in this case:

The problem that is presented by the phytoplankton is essentially how it is possible for a number of species to coexist in relatively isotropic or unstructured environment all competing for the same sorts of materials. (Hutchinson 1961, 137)

The primary explanatory aim in a case like this is to make the picture consistent—to decide on what in our explanatory belief system has to go when the explanandum is added (or, in simpler cases, to remove certain misconceptions we have about what this system implies). This is exactly the kind of situation Hempel focuses on in the first step of his account of how-possibly explanation. By implication, any attempt to adjust an explanatory theory so that it avoids falsification in the light of new evidence is a possible case of the phenomenon in which Hempel is interested. Sometimes, at least, the scientist thinks of such an enterprise in terms of explaining how-possibly. Hutchinson apparently did.

## 2. The reductive response: From how-possibly questions to why-answers

Normally, what happens in step one above is not the end of the explanatory process triggered by a Hempel-style how-possibly question. The explanation-seeking agent usually moves beyond the first stage of restored consistency. Hempel (1970, 429) claims that it is at this point that a why-explanation attempt naturally follows. The guiding idea seems to be that the *explanatory* features of how-possibly explanations reduce to this second step involving why-explanation:

Someone who asks how X could possibly have happened will not, as a rule, be satisfied to be told simply that he was mistaken in some of his empirical assumptions, which he thought precluded the occurrence of X; he will also want to be given a set of alternative, and presumably true, assumptions which, in conjunction with the rest of his background beliefs explain to him why X occurred. (Hempel 1970, 429)

There is an obvious problem with reductive theories set out along the lines Hempel suggests. For it cannot be ruled out that an enquiry will start with one type of explanation-seeking question, but continue with another. Mere awareness that there is an intermediary explanatory step of the kind described by Dray-Hempel gives us every reason to be sceptical about the reductive approach. A developmental account, in which both of the two stages are recognized as explanatory, would be a more modest position. Hempel clearly offers an interesting sketch of a developmental account of how-possibly explanation; whether it is, in addition, intended to be reductive we leave as an open question. It cannot be motivated by the context of Dray-Hempel how-possibly explanation unless the agent always moves directly from conflict and inconsistency to a new potential why-explanation.<sup>2</sup>

Going back somewhat in philosophical history, however, we find that it is frequently claimed precisely that every satisfactory explanation is an answer to a why-question. On this view, how-possibly explanation—to the extent that it is a form of *explanation*—can be nothing but why-explanation (see Salmon 1989, 136-137).<sup>3</sup> This view more clearly exemplifies the reductive ambition.

However, the above *prima facie* objection still stands. To merit discussion, the reductive account must be promising as a descriptive account. Therefore it is of interest to wonder whether there is an intermediary and explanatory first step in Dray-Hempel cases. In order to evaluate the position it will be useful to know whether yet other varieties of how-possibly explanation exist. If they do, that will further complicate the relations between how-possibly explanation and why-explanation. The reductive account presupposed by some why-explanationists would emerge as a rather unattractive one if, as I shall now argue, there are several distinct varieties of how-possibly explanation.

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<sup>2</sup> It may well be that Hempel thinks that this is the case, and that we can simply rephrase a how-possibly question as follows: “Why did this event (which I initially regarded as impossible or highly improbable) occur?” (Salmon 1989, 137). Hempel’s ensuing observation—that many why-question can be rephrased as how-possibly questions—does not settle this matter:

“[...] questions of the form ‘why is not the case that p?’ [...] might well be rephrased as ‘how-possibly’ questions: ‘How could it possibly be the case that not-p?’. Questions such as ‘Why doesn’t the Leaning Tower of Pisa topple over?’ or ‘Why don’t the antipodes fall off the earth?’, ‘If reflection in a plane mirror interchanges right and left, why not also top and bottom?’ will normally be raised only if the questioner entertains certain assumptions concerning relevant empirical matters which seem to him to make it certain or, at any rate, highly probable that the specified phenomenon should occur. A pragmatically adequate answer again will have to clear up the empirical or logical misapprehensions underlying this belief.” (Hempel 1970, 429)

What such examples can show, I think, is that some why-questions are complex, and that some how-possibly expressions are why-questions in disguise. If the observations in the present discussion are correct, both of these conclusions are very different from showing that every how-possibly explanation without residue can be rephrased as a why-explanation.

<sup>3</sup> However, the reductive perspective is often formulated and motivated rather casually: Cohen (1950, 259) requires of any explanation that it be an “appropriate answer to the question ‘why’ the explicandum is the case”; Braithwaite (1947, ii) states that an explanation is simply “any answer to a ‘why’ question which in any way answers the question, and thereby gives some degree of intellectual satisfaction to the questioner” (see Dray 1957, 156); van Fraassen (1980) echoes the remarks of these forerunners. Given their sweeping formulations, it is perhaps misleading to understand the positions of Cohen and his contemporaries as serious attempts at reduction at all.

### **3. Potential how-explanation: bracketing truth-claims and mapping the space of possibilities**

An alternative view of how-possibly explanation can be generated rather swiftly. The “possible” in “How is it possible that X?” may qualify a how-explanation in a way similar to that in which Hempel’s term “potential” in “potential explanation” qualifies a why-explanation. If it does, a particular how-possibly explanation will be quite like a how-explanation—though, of course, there will be a difference inasmuch as, in the former case, claims about the way world is that the explanans of the how-explanation involves will be bracketed in the how-*possibly* explanation.

I want to separate two possible ways of interpreting bracketing. It is advisable to do this, because we seem to have accounts of how-possibly explanation along both lines. I want to talk primarily of a literal, metaphysical sense of bracketing. But I also want to acknowledge its epistemic counterpart. In the metaphysical sense, bracketing stands for an intervention which robs the how-explanation of its implications about how the world is. On this reading, a how-possibly explanation does not *make the kind of claim* about the world that the how-explanation does. In the epistemic sense (to turn to its counterpart), bracketing reflects the fact that when we are dealing with how-possibly explanations we do not *know* whether the explanation is true. (This may be expressed in terms of the lack of adequate justification for how-possibly explanations.) On this reading, how-explanations are known to be true (or are adequately justified) whereas how-possibly explanations are not.

Whether the relevant explanations are conceived of as making no claims about the way the world is or as not being known to be true (or adequately justified), various reasons for being interested in potential how-explanations can be imagined. There is a spill-over effect here: from differences in explanatory interest to how, more precisely, one’s conception of how-possibly explanation of this sort is crafted. Before restricting the discussion to potential how-possibly explanations in the metaphysical sense,<sup>4</sup> I want, briefly, to introduce two explanatory interests that may result in potential how-possibly explanations.

The first example I select is discussed by Resnik (1991). In biology, he claims, certain explanations perform a scientific service despite their lack of adequate justification. Resnik (1991, 144) cites Darwin’s explanations of the origin of biological adaptations as an influential point in case. When discussing the evolution of bird wings, Darwin suggests that these could have developed in a series of evolutionary steps from appendages that were not capable of flight. This how-possibly explanation had many explanatory virtues, but the empirical evidence available at the time was fragmentary, at best. The same goes for many of today’s evolutionary explanations in biology as well as other disciplines.

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<sup>4</sup> Its epistemic counterpart will be dealt with, briefly, at the end of the paper.

Now, the concept Resnik develops clearly concerns epistemic bracketing, and it will not be discussed much further at this point.<sup>5</sup> In contrast, the conception I am concerned with here is the related phenomenon of bracketing truth-claims concerning any particular how-possibly explanation. However, the motivation behind Resnik's conception—it seems to me—fits nicely with both understandings of the view that how-possibly explanations are potential how-explanations of the second variety.

Perhaps the second example is even more to the point. Neurath (1916) suggests that in order to avoid reliance on “insight” historiography should proceed in two steps. First, in a particular field the elements out of which any particular theory could be reconstructed are to be identified. For instance, the optical theories of Huygens, Newton, Malebranche and others can be identified with the field of possible optical theories at a certain time. This first stage relies exclusively on “a purely logical point of view”. At it, all possible theories are regarded as having equal value. “A special pleading is needed if one of them is preferred” (Neurath 1916, 16; see also Reisch 1994, 168). Differentiating values are not introduced until the second stage. How-possibly explanations, on this understanding, span the space of possible options at a certain time:

For a best possible mastery of historical development it is desirable to make a preparatory survey of all groupings of individual views that are possible in principle. Maybe the start can be made from the theory of greatest power, if there is one of this character. (Neurath 1916, 30)

Several philosophers have advocated views like Neurath's. I will soon return to the role of how-possibly explanations in spanning the space of possibilities, but before doing this I want to give two illustrations of the basic conception of how-possibly explanation I am identifying.

Salmon (1989, 137) is an advocate of how-possibly explanations of the second variety. He believes that “a how-possibly question does not require an actual explanation; any potential explanation not ruled out by known facts is a suitable answer”. There is an epistemic residue in this characterization, but it is not farfetched to suggest that, for Salmon, we are entitled to make, not just the claim that a how-possibly explanation without adequate justification may be acceptable, but a stronger claim. It is of no relevance whether the how-possibly explanation happens to be ontic. In other words, the explanation *qua* how-possibly explanation does not involve any truth-claims concerning the explanans. These are bracketed in the metaphysical sense introduced earlier. The following, somewhat lengthy, quotation should make this clear:

[...] a DC-9 jet airplane recently crashed upon takeoff at Denver's Stapleton Airport during a snowstorm. One peculiar feature of this accident is that the plane flipped over onto its back. There are many explanations of a crash under the circumstances, but I wondered how it could have flipped over. Two how-possibly explanations were mentioned in the news reports. One is that it encountered wing-

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<sup>5</sup> According to Resnik, the lack of adequate empirical support is definitive of how-possibly explanation. How-possibly explanations may become how-actually explanations as science progresses. This position is reminiscent of Levi's (2003) understanding of dispositions, since the latter's dispositions can become real as science progresses. See also Persson (2006). Machamer et al. (2000) seem to be attracted to a similar idea.

tip turbulence from another airplane just after it became airborne. Another was suggested by the report of a survivor, who claimed that the plane was de-iced three times during its wait for departure, but that on the latter two of these occasions one wing, but not the other was treated. If one wing had an accumulation of ice on its leading edge while the other did not, the difference in lift provided by the two wings might have been sufficient cause for the plane to flip over. As I write this paragraph I have not yet heard the final determination regarding the cause of this crash. *Both potential explanations I have mentioned are satisfactory answers to the how-possibly question, but we do not know the correct answer to the why-question.* (Salmon 1989, 137, my emphasis)

Recent proponents of the second variety also include Machamer et al. (2000), Craver and Darden (2005), and Craver (2007). However, looking at their suggestions from the perspective I have suggested above reveals some differences that may lead to uncertainty about their positions so far as the two dimensions I have been examining are concerned. First, Machamer et al. (2000) invite us to think about “how-possibly, how-plausibly, and how-actually”, thereby encouraging epistemic interpretation of their work. Second, Craver and Darden (2005, 236) seem to suggest a metaphysical, error-theory interpretation of how-possibly explanations. At least, that is one way of reading the following passage:

The observable phenomena of the natural world are to be explained in terms of hidden mechanisms, and these mechanisms are to be inferred using well controlled experiments to sort how-actually from how-possibly descriptions of mechanisms.

The need for, as well as the nature of, the business of sorting out implies that how-possibly explanations make claims about the world—claims which are in fact false (*sic*). The following remark of Craver’s (2007, 112) can be interpreted in both ways:

How-possibly models are often heuristically useful in constructing and exploring the space of possible mechanisms, but they are not adequate explanations.

In keeping with the views of Neurath and Salmon, Craver claims that when explaining how-possibly one need not presuppose that the explanans elements exist, nor—if they do—that they are organized in reality in the way they are in the model. *Prima facie* no truth-claim concerning the particular how-possibly explanans needs to be involved in this characterization. However, the final verdict depends on what it is that makes how-possibly explanations inadequate. Is it—*pace* Craver and Darden (2005)—that they bracket claims about truth (metaphysical interpretation)? Is it that they are false (metaphysical error theory)? Or is it rather that they lack justification (epistemic interpretation)? Well, it seems safe to conclude that it is one of these three. How-actually models, by contrast, (claim to) describe real features of the mechanism that in fact produces the explanandum phenomenon.

One of the examples Craver (2007) deploys, from neuroscience, concerns the history of the discovery of the action potential. More specifically, it centres on the possibility that ions are conveyed across the membrane by active transport. Bertil Hille developed a model which is now textbook material. In it, changes in action potentials are explained

by the opening and closing of transmembrane channels. To begin with, Hille (1992) presented several how-possibly models. They differed in their parts, and in the activities in which the parts were claimed to be involved, as well as in the way the mechanisms were organized:

There are swinging gates, sliding gates, free-floating blockers, tethered balls and chains, rotating cylinders, and assembling components. Hille intended these as merely how-possibly models because he had no idea whether the channels would turn out to have parts of the requisite sort, or whether the parts could act as the model requires, or whether their activities were organized in the way that the model suggests. (Craver 2007, 117-118)

This final illustration combines the two features with which we have been concerned in this section on how-possibly explanation as potential how-explanation. First, according to Craver's description Hille's model is a how-possibly explanation since it brackets claims about the way the world is (metaphysical interpretation). This decision reflects the limited extent of our knowledge. Second, the model utilizes these how-possibly explanations to map the space of possible explanations. Most of these possible explanations, it later turned out, could be ruled out in the face of known constraints and plausibility arguments (see Craver 2007, 118).

More could be said about this family of relatively common interpretations of how-possibly explanations. However, the cluster of conceptions offered so far make the need for yet another complementary understanding of how-possibly explanation obvious. This complementary conception constitutes this article's primary addition to our knowledge of how-possibly explanations.

Before we move on, however, we need to note that the second variety of how-possibly explanations (potential how-explanations) and the first (Dray-Hempel) differ in several ways. Dray-Hempel how-possibly explanations need not be substantial explanations, let alone substantial how-explanations. They are not really concerned with the *explanans* side of the explanation. By contrast, potential how-explanations require many of the explanatory virtues of actual how-explanations. Exactly which virtues, if any, they *cannot have* is unsettled. According to Resnik (1990) and Craver (2007) they should not be backed up by adequate empirical evidence.<sup>6</sup> Neurath (1916) and Salmon (1989), as I read them, suggest instead that in how-possibly explanations truth-claims regarding the explanans are bracketed. That is, the potential explanation may be an actual—i.e. ontic or true—or an adequately backed-up explanation, but whether or not this is so is of no relevance in the context of how-possibly explanation.

Let us now ponder the following question: In what scientific contexts do these two varieties of how-possibly explanation appear? Dray-Hempel explanation occurs in an environment of conflicting beliefs and a certain sort of puzzlement. The context of the second variety, by contrast, is typically one of discovery, hypothesis generation, or the exploration of a range of possible explanations in a research environment where the

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<sup>6</sup> And, as already noted, in some places Craver and Darden might add the further restriction that the how-possibly explanation is actually false.



explanandum phenomenon is accepted as a fact and now needs to be integrated with the system.

#### **4. Partial how-explanation: claiming the existence of an ontically explanatory mechanism**

It is time to introduce yet another conception of how-possibly explanation. Inevitably, the fact that the first and second varieties of explanation make no claims concerning the truth of the explanans in the actual world, or locate at best inadequate empirical support for that explanans, provides room for independent conceptions. These negative features imply that the first and second varieties of explanation will not generalize to certain, apparently important, cases. Some how-possibly explanations entail more factual and/or more empirically justified claims than the varieties of how-explanation explored above can harbour. Below are just a few examples that testify to this fact:

A fundamental question is how it is possible for the shuttling transport receptors to carry their cargo in only one direction. (Kutay et al. 2007)

By studying the biology of coral reproduction and recruitment, we gain an understanding of how it is possible to slowly degrade a reef. (Richmond 1997, 175)

By starvation and by oxygenation and by a combination of starvation and oxygenation we have seen how it is possible to shift the protozoa about almost any way we wish. (Cleveland 1925, 317)

Apparently, in these cases the desired answers are not merely ways the world *might have been* in order to produce the explanandum phenomena. So, *pace* Salmon (1989, 138), far from “any potential explanation not ruled out by known facts is a suitable answer” to these three problems. The reason is that it matters a lot to the explanations on offer whether they depict facts or not. For instance, the passage in Richmond (1997) continues: “This understanding is of central importance to coral-reef management and preservation”. It matters even more—to the researchers themselves, that is—whether the how-possibly explanations on offer are empirically justified. How-possibly explanations in this group clearly make claims about the world. They must usually be supported by adequate evidence. Hence there is disagreement between the third variety and the second variety of how-possibly explanation regardless of our interpretation of potential explanations. Conflict appears whether potential how-explanations are interpreted metaphysically or epistemically.

However, the primary interpretation of the group of how-possibly explanations we are concerned with now is metaphysical, or—as I prefer to say—*ontic*. What we need, as an explanans, are facts that make the explanandum phenomenon physically (or, in these cases, biologically) possible by providing a partial mechanism that in fact had the explanandum as outcome.

Let us expand briefly on the latest example. L. R. Cleveland is interested in the symbiosis between termites and their intestinal protozoa. With protozoa the termites seem to be able to feed only on wood; without protozoa this diet kills them within a few weeks. In this particular study, Cleveland wanted to find out how (i.e. in what ways) it is possible for the presence of protozoa in termites to vary. He conjectured that oxygen could be one key to understanding this variation, since high levels of oxygen are toxic to many species. In his experiments he found that, whereas the protozoa quickly died from oxygen exposure, the termites proved to be unaffected by even high levels of oxygen. “They easily live eight to ten days in an oxygen atmosphere which kills their intestinal protozoa in three days” (Cleveland 1925, 316). Similarly, starvation proved effective. The protozoa died well before their hosts did in circumstances of starvation.

These experimental results encouraged Cleveland to believe that he has found the answer to his how-possibly question. This demonstrates, immediately, that the how-possibly question posed in this context is one of neither epistemic inconsistency nor mere potentiality in Neurath’s or Salmon’s sense. Indirectly, it also shows that Resnik’s (1991) analysis of how-possibly explanations in biology does not cover this case.<sup>7</sup> As we remember, Resnik explicitly attempted to characterize how-possibly explanations in biology precisely by their lack of adequate empirical evidence:

An explanation is a how-possibly explanation if and only if it 1) lacks adequate empirical support, but 2) still satisfies other explanatory virtues. (Resnik 1991, 143)

The support Cleveland and others provide in favour of their conclusions that they have found part of the ontic explanation normally involves rather impressive experimental data.

A conceptual question remains. Why are these *possibly*-explanations? Are they not a little too *actual* for that to be the case? My basic contention is that they deserve the epithet “possible” because they posit the existence of a mechanism without which the explanandum phenomenon would not have been produced (in the actual way this happened), even though this part of the story is not sufficient to account for the truth of the explanandum.<sup>8</sup> These explanations are about a mechanistic or, broadly speaking, ontic sense of this-worldly possibility. This possibility is established by providing the mechanistic truth-maker needed for claims about how the phenomenon could—and in fact did—come about. However, such explanations amount to less than a complete how-explanation in that they may not include all the mechanistic facts we may need in order to see more precisely how the explanandum phenomenon was produced.

In this sense the third variety of how-possibly explanation identified here is doubly interesting to compare with potential how-explanations. It seems that the present variety can be formulated like this:

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<sup>7</sup> It is trivial that this how-possibly explanation does not imply that the explanans is inadequate or—worse still—false.

<sup>8</sup> Of course, a number of complications should be contemplated at this point—especially the possibility that several mechanisms yielding the same outcome exist. However, these complications do not matter in the present context, where the only thing I wish to point out is the distinctness of this variety of how-possibly explanation in comparison with the other varieties I have identified.

An explanation is a how-possibly explanation if and only if it 1) is an ontic explanation, but 2) lacks certain other explanatory features of how-explanations.

## **5. How and how possibly**

In a number of accounts of them, how-explanations crucially involve causal or mechanistic details. Dray, for instance, acknowledges this feature in connection with historical how-explanations:

‘Explaining how’ may also mean making clear the detailed steps by which something came about. Thus Chester Wilmot states the theme of his recent book, *The Struggle for Europe*, as: “Not only how Hitler was overthrown but how Stalin emerged victorious, how Russia came to replace Germany as the dominant power in Europe, and how Stalin succeeded in obtaining from Roosevelt and Churchill what he failed to obtain from Hitler.” This sense of ‘explaining how’ is a very common one in history, but it is quite different from explaining how something could be so. (Dray 1957, 166-167)

As this paper shows, I do not necessarily agree with Dray on what it is to explain how something could be so. What I do agree on is that it is rather easy to separate typical how-possibly explanations and typical how-explanations by attending diligently to the amount of causal detail. How-possibly explanations diverge from and overlap with how-explanations by being partial how-explanations. This possibility, however, is absent in the second variety. Potential how-explanations are just like complete how-explanations in this respect.

## **6. In favour of how-possibly explanations of the third variety**

Mechanisms are seldom causally isolated: causal interaction runs beyond their boundaries and between them. To fill in the causal details of one how-explanation one sometimes needs to establish the existence of surrounding mechanisms. And often, in biology at least, one is expected to back up a how-explanation with something more than an evolutionary just-so story. How-possibly explanations of the third variety are just what we need here.

I feel less convinced that Resnik’s variety, let alone Salmon and Craver’s, stands the test. For even when we view Resnik’s account merely as a heuristic, we probably ask both for too much and too little if we try to present potential how-explanations without adequate empirical support. And, normally at any rate, a potential how-explanation that makes no claims about the existence of the explanans is bound to be unsatisfactory (as, *a fortiori*, is one that implicitly denies that the explanans exists).

In saying that it is often to ask for too much, I mean that, often, one partial mechanistic framework will be adequate. We seldom move forward by first conjecturing about all of the details of every potential how-explanation. Moreover, if we are ignorant, to some

extent, about the way the world really is, it is painful—and useless—to engage in such an activity.

In saying that it is often to ask for too little, I mean that, often, parts of the proposed potential how-explanations ought to enjoy empirical support. It accords better with “good” biological science to secure support in favour of the crucial elements of the how-possibly explanation and leave the rest of the potential how-explanation sketchy or blank for the purpose of other studies. But the varieties of potential how-explanation we have pondered seem to involve and require an absence of support, or even an avoidance of existential claims; both of these features make them unsuitable for the job.

I am speculating somewhat here; but an odd thing this exercise has in effect uncovered is that, had the topic been why-explanations, little time would probably have been spent on the issue of potential why-explanation. Lipton (2004) acknowledges that inference to the best explanation should be interpreted as inference to the best *potential* explanation, and he does for the obvious reason that our “inductive” scientific inferences are fallible. The implication is that the divide between actual and potential is not terribly interesting if our concern is to sort explanations in actual science.

This seems to create a dilemma for advocates of the second variety of how-possibly explanation. First, unless the requirement on the second variety is that the empirical support should be virtually none, or that no existential claims should be involved, it is difficult to uphold the difference between how-possibly explanations and ordinary how-explanations we meet with in scientific practice. On the other hand, if this requirement is met, it will follow that how-possibly explanations are rather uncommon, and that the potential how-explanations that frequently occur in science must be of another variety. For instance, the category of *potential* partial how-explanation, i.e. potential how-possibly explanations of the third variety I have distinguished, should be more common if the observations in this section are right. This, too, seems to raise how-possibly explanations of the third sort to a more important level, practically speaking, than other varieties that we also report sometimes with expressions such as “how possibly X”.

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