Ontic Explanation Is either Ontic or Explanatory, but Not Both

CORY WRIGHT
Department of Philosophy, California State University Long Beach

DINGMAR VAN ECK
Centre for Logic and Philosophy of Science, Department of Philosophy and Moral Sciences, Universiteit Gent

This paper advances three related arguments showing that the ontic conception of explanation (OC), which is often adverted to in the mechanistic literature, is inferentially and conceptually incapacitated, and in ways that square poorly with scientific practice. Firstly, the main argument that would speak in favor of OC is invalid, and faces several objections. Secondly, OC's superimposition of ontic explanation and singular causation leaves it unable to accommodate scientifically important explanations. Finally, attempts to salvage OC by reframing it in terms of 'ontic constraints' just concedes the debate to the epistemic conception of explanation. Together, these arguments indicate that the epistemic conception is more or less the only game in town.

Keywords: causation, explanation, explanatory knowledge, mechanism, ontic conception, normative constraints

> Planting a stick in this water is probably futile,
> but having done it before I shall do it again,
> and—who knows?—enough sticks may make a
> dam, and the waters of error may subside.
>
> – Simon Blackburn

Contact: Cory Wright <cory.wright@csulb.edu> and Dingmar Van Eck <dingmar.vaneck@ugent.be>

1. Two Conceptions of Explanation

What features will something have if it counts as an explanation? And will something count as an explanation if it has those features? In the second half of the 20th century, philosophers of science set for themselves the task of answering such questions, just as a priori conceptual analysis was generally falling out of favor. And as it did, most philosophers of science just moved on to more manageable questions about the varieties of explanation (functional, causal, mathematical, statistical, mechanical, nomological, historical, etc.) and discipline-specific scientific explanation (chemical, cellular, cognitive, etc.). Often, such shifts are sound strategies for problem-solving. But leaving fallow certain basic conceptual issues can also result in foundational debates.

While the 20th century closed with no real consensus about the nature of explanation, most presumed that, at bottom, explanations belong to a special class of representations. Sufficient to generate this presumption are the thoughts that any explanation is an attempt to account for something, and that any attempt to account for something necessarily represents matters as being a certain way, as being this way or that or not.[1] Although maximally schematic, this underlying presumption is neither trivial nor universally accepted. Its main utility resides in organizing the various accounts that elaborate the specific nature of the representations involved, and the operations on them, that relate explanantia and explananda.

At the beginning of the 21st century, however, proponents of the ontic conception summoned philosophers of science back to the task of a priori conceptual analysis by calling this presumption into question. What resulted was a foundational debate between two conceptions of explanation, which have come to be known as *the epistemic conception* (EC) and *the ontic conception* (OC).

Both EC and OC are conceptions of explanation per se; that is, they provide an explicative answer to the philosophical question *what is an explanation?* According to EC, explanations are complexes of representations of entities in the physical world.[2] But EC is so called because it takes these representations to aim at increased knowledge about the entities in the physical world, and it takes the norms of explanation to be the norms of knowledge. So, while not every complex of rep-

---

1. A simple, early example comes from Hempel and Oppenheim's claim that explanations are relations between descriptive and elucidatory sentences: '[w]e divide an explanation into two major constituents, the explanandum and the explanans. By the explanandum, we understand the sentence describing the phenomenon to be explained (not that phenomenon itself); by the explanans, the class of those sentences which are adduced to account for the phenomenon' (1948: 136–137).

2. EC is roughly what Bokulich (2018) calls the *eikonic conception* and the *San Diego School of explanation* (presumably because of the ties to Kitcher, Churchland, Perini, Bechtel, Wright, Sheredos and others).

resentations satisfying these norms necessarily is an explanation, presumably every explanation satisfying these norms will be a complex of representations.

According to the ontic conception (OC), however, explanations are instead complexes of the physical entities so represented, which are located among the other spatiotemporal parts of reality and which do not aim at norms of goodness. As Craver put it, '[ontic] explanations are not texts; they are full-bodied things. They are facts, not representations. [. . .] There is no question of [ontic] explanations being "right" or "wrong," or "good" or "bad." They just are' (2007: 27). Likewise, Jenkins writes that they are 'worldly things', that is, 'not the sort of things that are true or false, but rather the sorts of things that take place or obtain, such as facts or events' (2008: 64).[3] In other words, according to OC, explanations are physical entities that subsist in re and participate in the causal structure of the world, whose production or subsistence is not conditional upon the effects or existence of cognitive subjects.[4]

One way to think about what's at issue between these two conceptions is whether the theory of explanation should find its proper home in epistemology and cognitive science. Most philosophers of science have endorsed the thought that it should. 'This ontic orientation may seem peculiar in the case of explanation', wrote Humphreys, 'for explanation has traditionally been taken to be squarely in the realm of epistemology' (1989: 3).[5] And as Ruben noted, the issue is not merely one of historical tradition, but one of conceptual analysis: '[t]he analysis of explanation belongs to general epistemology, in the same way as the analysis of knowledge does, and not just to the philosophy of science, narrowly conceived. Scientific explanation, like scientific knowledge, has a special importance and pride of place in a general theory of knowledge' (1990: 6). Faye affirmed the point: 'Explanation is not an ontic category but an epistemic one' (1999: 61). Lycan concurred: '[e]xplanation and epistemology are closely related [. . . T]he notion of explanation is itself an epistemic one. To explain something

---

3. Jenkins also summarizes it as the claim that 'whether p explains q is a matter of how things stand in reality; usually mind-independent reality' (2008: 66). But that thought is at least one too few; for not only does it treat explanation as a relation between propositions, which is inconsistent with OC, but the idea that explanatory relations depend on reality is just a nod toward a generic realism, which most versions of EC can easily accommodate. But the idea that the proposition that p must satisfy a normative constraint or condition, such as correspondence or accuracy, in order to be a good explanation of q likewise implies an epistemic conception; and that may be one thought too many.

4. Forge (1986: 127, 141) and Illari and Williamson (2011: 821) also call it *physical explanation*; Jenkins (2008: 64ff.) calls it *real explanation*.

5. Why peculiar? As recent commentators have clarified, OC has curious implications: that there could never be multiple competing good or bad explanations for a given phenomenon (Waskan 2006: 201–202); that scientists can give actual descriptions but not actual explanations (Wright 2015: 20–21); that study of the physical world is unnecessary for physical explanations (Bokulich 2016: 263ff.); that explanations have no unimportant or irrelevant parts (Târziu 2018); etc.

is an epistemic act, and to have something explained to you is to learn' (2005: 408). More recently, the reprisal of these claims has also been applied to mechanistic explanation in particular, which has become the debate's center of gravity. For Bechtel, '[e]xplanation is fundamentally an epistemic activity performed by scientists' (2008: 18). And the presumption that mechanistic explanations in particular belong to a special subclass of representations is just an implication of the epistemic nature of this activity: for example, 'since explanation is itself an epistemic activity, what figures in it are not the mechanisms in the world, but representations of them' (Bechtel 2005: 425; Şerban 2013). For their part, proponents of OC assert the opposite: since explanations are ontic, what figures in them are not representations, but the mechanisms in the world. As Illari and Williamson contend, 'mechanisms explain the phenomena they explain by being [causally] responsible for them' (2011: 821); similarly, Halina writes, 'the causal mechanism that produces, constitutes, or maintains a phenomenon of interest explains that phenomenon' (2015: 3). The thought that the ϕ-ing of a mechanism is the phenomenon ϕ it produces, when combined with OC, implies that iterations of mechanistic activities are acts of (self-)explanation.

As foundational debates go, this one has nontrivial consequences for philosophy of science. A lack of resolution has left the fate of the mechanistic and causal accounts of explanation in the lurch. It also shifts the discipline away from the practice-oriented approach. As Woody put it, '[i]gnoring the [intimate relationship between explanation and representation in science] may hinder efforts to understand the vital role that explanatory discourse plays in the sciences, and in intellectual pursuits generally' (2004: 781). Perhaps most astonishingly, if OC is correct, the fact that most philosophers of science have endorsed the thought that explanation is an epistemic category or activity implies that most philosophers of science have unwittingly misconceived of the nature of explanation. If EC is correct, the problems of scientific explanation just become special problems of scientific representation, in so far as there are any (see Suárez 2010).

These and other consequences have tempted some into looking for a swift dissolution. For instance, one occasionally sees the suggestion that the debate is merely terminological. This is interpretatively uncharitable to proponents of OC, however, who have striven to advance a subversive answer to a substantive conceptual question, *what are explanations?* In answering that explanations are non-representational, mind-independent parts of the causal structure of the world, proponents of OC attempt to reconceive the traditional presumption about the very nature of explanation. Another suggested dissolution is the hopeful falsehood that there is a less radical or moderate or weaker version of OC, according to which explanations are descriptions and models of real-world phenomena that satisfy so-called *ontic constraints*. Since that claim is entailed by the central thesis of EC, no version of OC could endorse it while denying EC; and

so any such version would be committed to EC in some straightforwardly self-abnegating way. Philosophers claiming to take up only the weaker or moderate or less radical versions of OC have therefore misunderstood the irreconcilable differences between OC and EC: there is no such middle ground to be had.[6] The central divergence between proponents of EC and OC concerns whether explanations are representations of entities in the world or the worldly entities so represented.[7] The divergence is also conceptually basic, as Salmon himself saw clearly: 'the shift from the epistemic to the ontic conception involves nothing less than a radical gestalt switch' (1984: 277). Given the contradictory nature of these two conceptions, if EC is correct then OC cannot be, and vice-versa.

Following some additional stage-setting in Section 2, this paper helps resolve this debate by clarifying the main argument for OC in Section 3. Once clarified, the central objections are easier to see; so too are the ways in which key inferential steps are unsupported.[8] In Section 4, we elaborate a (related) problem: proponents of OC take causation to be, at root, singular causation (e.g., Salmon 1984; Forge 1986; Glennan 2011). This is confirmed in their core examples of ontic explanations as token occurrences of an event 'explained' by a singular causal interaction. However, as they also acknowledge, explanations with scientific import or interest are those implicating classes, abstracta, genera, variables, universals, and other entities that are appropriate for satisfying typological norms, but not for participating as the relata of singular causal relationships. OC is thus saddled with a dilemma that pits being ontic against being explanatory. In Section 5, we argue that OC also cannot be developed in the guise of an 'ontic constraint' account, without just conceding that the debate is about explanations, epistemically conceived. All told, the master argument for OC is not sufficiently compelling; and whereas OC delivers something unwanted that EC does not (a dilemma regarding singular causation), OC cannot deliver something important that EC can (a normative turn toward a 'productive' debate).

---

6. Some proponents of OC have seen this clearly: e.g., '[o]ntic explanations cannot conform to representational ideals of completeness [or accuracy] because they are not representations' (Halina 2015: 4; cf. Kaiser 2014; Şerban 2017).

7. For characterizations of this divergence, see, e.g., Forge (1986: 131–134; 1993: 84–91; 1999: 10–15), Salmon (1989: 86, 133), Wright and Bechtel (2007: 46–52), Craver (2007: 27; 2014: 36), Strevens (2008: 6–8), Kaiser (2014: 158–161), van Eck (2015: 7–8), Wright (2015: 20–22), Bokulich (2016: 263ff.).

8. We hasten to add EC has its own objections to deal with. For instance, proponents sometimes declare the explanation-constituting representations to be either descriptions or else answers to *why-* or *how-*questions, but then fail to articulate what converts description into explanation or what criteria pick out which *why-* or *how-*questions are requests for explanation (given that not all are). Others fail to properly distinguish between representations and their use, and still others conflate explanation and understanding.

2. EC: Some Preliminary Clarifications

This section offers some historical and conceptual background to the debate. Beyond just setting the stage for discussion in Sections 3–5, it serves two clarificatory goals. First is to reconsider the narrow identification of EC with views from the mid-century 'logic of explanation' movement. Second is to clarify some neighboring distinctions that do not track the distinction between EC and OC. Readers familiar with this background can skip to Section 3.

The philosophical focus on explanation in the 19th and early 20th centuries concerned a contrast between what von Wright and others classified as an older Aristotelian tradition and a newer Galilean one: 'the contrast between the two traditions is usually characterized as causal versus teleological. The first type of explanation is also called mechanistic, the second finalistic' (1971: 2). Salmon's work was instrumental in updating this contrast. Throughout his career, he offered portraits of competing ways of thinking about scientific explanation. Several were self-portraits; some were detailed landscapes; one or two others were impressionist snapshots of certain debates; and still others canvassed the nuances of a single argument or two. Salmon's favorite sitting subject, however, seems to have been the contrast between what he called the 'two grand traditions of scientific explanation' (1984: 15–20, 84ff.; 1998: 69, 126, 320). The first was a replacement of the older Aristotelian tradition alluded to by von Wright. Salmon called it *the epistemic conception*, characterized by its focus on logic and laws, and summarized by Hempel's (1965: 488) slogan that to explain is to show that a phenomenon ϕ fits into a nomic nexus. The second was effectively an update of the newer Galilean tradition. Salmon called it *the ontic conception*, characterized it by its focus on causality and events, and summarized it by his own (1984: 19, 132) slogan that to explain ϕ is to show how it fits into a causal nexus.

Salmon's distinction between these two grand traditions was less than tidy. Initially, the two grand traditions began as three (1984: 15–17, 84ff.); the modal conception was gradually disregarded. In the introduction to his classic *Four Decades*, he (1989: 3–4) distinguished what he called the 'old consensus' from the 'new consensus'. Rather than the traditions characterized by von Wright, they were determined chronologically: the old consensus corresponds to Salmon's own first two decades (1948–1967) and derives from Hempel and Oppenheim's (1948) classic paper, while the new consensus corresponds to his following four decades (1968–current) and ultimately consists in a response to the old consensus. (Salmon went on to suggest that this 'response' to the old consensus was little more than a rejection of it, which doesn't make for a grand tradition.) Immediately following this distinction, Salmon reduces 'the old consensus' to the conjunction of Hempel's D-N and I-S models of scientific explanation (1989: 4). Later, he added the D-S model and renamed the conjunction of it with the old

consensus 'the received view'—a taxonomy that he previously identified as the 'inferential conception' (Salmon 1984: ix). Matters get murkier still, but this is at least a flavor.

Salmon seems to have settled on dividing EC into three versions, the most central being the so-called *inferential version*. According to that version, explaining involves making first-order inferences from explanans-statements to an explanandum-statement. It has two main features: (i) logical necessity and (ii) nomic expectability (Salmon 1984: 16, 84ff.). Firstly, an explanation E for some phenomenon ϕ is an argument with at least one premise stating a law and at least one premise stating initial/boundary conditions, such that the truth of those premises logically necessitates the truth of the conclusion stating ϕ. Secondly, singular events or instances of laws are therefore subsumed or 'covered' under more general laws, such that one should rationally be able to expect the explanandum to be the case given her knowledge of the general laws and initial conditions.

Many philosophers have followed Salmon in treating EC to be little more than this inferential version. Of course, the role of arguments in Hempel's nomological accounts is well-known; and Kitcher's (1981) unificationist version has scientists applying sets of argument patterns so as to derive a maximally unified explanatory store, $E(K)$, over axiomatizations of sets of accepted beliefs K. Unfortunately, and in large part because of the role of inference and argumentation in these two well-known versions of EC, the contrast between Salmon's two grand traditions is often mistakenly reduced to the question of whether or not explanations are arguments. For instance, according to Glennan, Salmon's view was that '[e]xplanations are not arguments' (2002: S343). According to Craver, 'Salmon's most penetrating insight was to abandon the idea—explicit in the covering law model and Kitcher's unification-model—that explanations are arguments' (2007: 26–27). However, the 'penetrating insight' was not actually Salmon's considered view, as he himself confessed: '[i]n my zeal to rebut the claim that all explanations are arguments, I argued that no explanations are arguments. This view now seems too extreme; as it seems to me now, some are and some are not' (1989: 101; see also 1975: 163). Consequently, mistaking EC for the thesis that explanations are arguments, and assuming that OC is defined by its opposition to this thesis, too narrowly circumscribes EC.

Many philosophers have also followed Salmon in not only treating EC to be little more than this inferential version, but also in treating this inferential version to be Hempel's covering law model tout court.[9] While EC is broad enough

---

9. Recall Salmon's admission that his own attempts to assimilate EC to Hempel's models were misguided (1989: 101), his concession that '[t]he causal/mechanistic version of [OC] is as much a covering-law conception as is any version of [EC]' (1984: 262), and his proposal for proponents of OC to lay claim to the inferential version of EC (1989: 86).

to accommodate a constraint that explanantia include either a law of nature or a scientific law, this constraint would issue from the nomological account of explanation, not EC. And yet, EC has been frequently mistaken for a nomological account of explanation. An example is Şerban's (2017: 44) suggestion that being an alternative to the traditional nomological account of explanation is a primary consideration that motivates OC. Her suggestion ignores the fact that the nomological and causal accounts of explanation cross-cut the distinction between EC and OC.[10] This point is made more salient by Bokulich's helpful distinction between claims about what explanations are (*conceptions*) versus claims about how explanations work (*accounts*). Accordingly, one can endorse EC without having to endorse the claim that all explanations involve citing and representing the relevant laws. By the same token, though, Bokulich observes that

> [o]ne can, however, reject the ontic conception (i.e., deny that explanations are things in the world, independent of human theorizing), but endorse the view that many explanations are indeed causal (i.e., involve citing and representing the relevant subset of causes of the phenomenon). (2016: 263)

This distinction also allows us to see the conflation in Salmon's contrast between his 'two grand traditions'. This conflation was observed earlier by Kim, who noted that 'the term *epistemic*, as used by Salmon, is also misleading. I think it should be granted on all hands that explanation is epistemic (what else could it be?)' (1994: 58, Footnote 8). Likewise, de Regt wrote that 'Salmon's distinction is misleading: explanations, also Salmon's causal-mechanical ones, are always epistemic and not ontic, in the sense that they are items of knowledge. I submit that any explanation is a structured epistemic item' (2015: 3793, Footnote 17).

To get clearer about the sense in which scientific explanations are complexes of representations about entities in the physical world, it helps to detach from Salmon's semi-autobiographical history of his two grand traditions and

---

10. Şerban (2017: §2) offers another consideration intended to motivate OC, claiming that it secures the objectivity of scientific explanations by grounding them in causal dependency relations in the world. Like her first consideration, this one also doesn't do anything for OC that it doesn't also do for virtually all other conceptions of explanation. Every conception that allows causal dependencies in the world to be the intentional objects of explanatory knowledge—nearly all of them—will satisfy the second consideration. Moreover, as Şerban (2013) herself noted earlier, objectivity is a structural feature of representation, no less than specificity, tenselessness, descriptive adequacy, alethic modality, and so forth; and so it makes sense to talk about the objectivity of explanations being grounded in the world only if explanations are already being conceived epistemically. Since proponents of OC have made clear that there is no question of ontic explanations being right or wrong, good or bad, or fully objective or implicitly subjective, Şerban's second consideration is not sufficiently coherent to do the job she asks of it.

to consider EC in a general fashion, so as not to preclude any of its versions. Complexes are structured assemblies. The representations recruited in these assemblies can be conceived as polyadic vehicle/content/target relations; still other conceptions are possible. The kinds and modes of representation vary widely, from directed acyclic graphs diagramming causal operations in mechanisms to differential equations to propositional functions from interrogatives to answers given an expression relation, and far beyond. How, then, to understand the term *complexes of representations* depends on which constraints and commitments from which accounts (e.g., erotetic, causal, nomological, inferential, etc.) are under consideration.

Not all versions of EC treat the operations on representations necessary for producing explanatory knowledge as logical operations on sentences in first-order logic. Churchland (1990), for instance, reconceives of scientific explanation as a kind of reconfiguration of synaptic weights in neurocomputational state-space, in which the representations are vectors and the operations on them are vector-to-vector transformations that assimilate novel neuronal representations of phenomena to attractors. Similarly, for Thagard (1998), scientific explanation involves making reasonable and coherent non-deductive inferences, which take the form of solving constraint-satisfaction problems; solving such problems involves implementing heuristics at Marr's algorithmic level for computing a coherence function.

While these two versions of EC theorize at the subpersonal level, there is also the cognitivist tradition of construing explanatory representations as internal mental models of external affairs. This includes Craik's (1943) version, which construed explanations as processes of translation and mental manipulation of physically isomorphic scale models; Johnson-Laird's (1983) treatment of explanation as a subspecies of reasoning with formal possibility tableaux; Waskan's (2006) version, which posits exductive inferences over image-specific intrinsic cognitive models; and Fauconnier's 'mental space' theory, which posits base, input, and blended mental spaces—'partial assemblies of cognitive potential'—constructed in online thought and speech via operations such as compression, mapping, identification, blending, integration, etc. Some discussions of mechanistic explanation have also focused on the cognitive operations involved in reasoning with diagrams, images, and other iconic or non-linguaformal representations of mechanisms—particularly, visuospatial animation and mental simulation (Hegarty 2004; Perini 2005; Bechtel 2017).

There are also information-theoretic versions of EC, which characterize explanations as essentially algebraic operations on probabilistically defined units of information. Erotetic versions, speech act, and 'communication-first' analyses focus on the conditions under which representations such as illocutionary utterances count as satisfactory answers to *why-* and *how*-requests for explanations

(Achinstein 1983; Potochnik 2017: §§5.1–5.2). For present purposes, we can be silent on all of the more important, but further, questions about what versions of EC fare best, how to analyze the extension of *operation*, how to delimit representations, what the norms governing such representations are, and what the problems of each version are. The important point is that EC is much more expansive than is usually acknowledged: explanatory representation is a big tent.

Unsurprisingly, those with interests in scientific practice and the pragmatic features of explanation have gone beyond EC to focus on intelligibility or understanding in addition to explanatory knowledge: for example, '[n]ot deducibility, but intelligibility constitutes the basic feature of the logic of explanation; understanding and intelligibility are the basic controls operative in every context' (Yolton 1959: 207). While proponents of EC theorize about various operations on explanatory representations aiming at de re explanatory knowledge, the relationship of this conception to understanding and intelligibility is unclear. And while understanding and intelligibility are important issues, they often confound the debate between EC and OC. A salient example is Jenkins' (2008) classification, which opposes a conception of in re explanation with an account of the feeling of understanding, which she calls *all-in-the-mind explanation*. Another example comes from Marcus's paper (2014) on the role of mathematical beliefs in scientific explanations. Marcus distinguishes between two incompatible senses of explanation, which he calls *metaphysical* and *epistemic*. Metaphysical explanations are those that aim to 'express the deep structure of the world', and are evaluated 'largely on how well they represent the structure of the world' (2014: 346). As examples, however, Marcus cites the nomological, unificationist, and causal-mechanical accounts. Consequently, his characterization of metaphysical explanation fits more with EC than OC, and likewise fails to distinguish between claims about what explanations are versus claims about how they work. Epistemic explanations, by contrast, 'aim at increasing the understanding of an individual' and at providing answers to 'ordinary *why*-questions', and they 'may be independent of the way the world is without failing, for that reason, to be explanatory' (2014: 348); they also 'may include claims which are useful for that purpose without being true' (2014: 346). And they are evaluated in terms of their intelligibility for a particular audience. Without wanting to deny these philosophers' characterizations of understanding, we do note that clarifying the debate between OC and EC requires taking care to distinguish it from certain neighboring debates that superficially appear to track the distinction but do not.

Relatedly, EC and the pragmatist conception of explanation (PC) are often happily combined. The thought that explaining is an activity by which human agents convey knowledge to each other has been interpreted as a core commitment of both EC and PC, for instance. Numerous philosophers have contended that to explain something is to engage in norm-governed ratiocinative or com-

municative practices (from which the nominalization *explanation* derives—not vice versa).[11] The confluence of both epistemic and pragmatic conceptions of explanation also requires care and clarification. For example, Humphreys wrote:

> [a]n emphasis on pragmatic aspects of explanations often arises when one views explanations as devices intended to convey understanding. Rather than focusing on the objective features of the world that constitute, for us, an explanation of a given phenomenon, or on the logical structure of an explanatory device, as Hempel did with arguments, pragmatists tend to be concerned with the epistemic state of an inquirer. (1989: 127)

Pragmatists may indeed be focused on the epistemic states of inquirers. However, it does not follow that proponents of EC must go beyond their conception of explanation in order to sweep in claims about pragmatics of using those representations. That these issues synergistically go hand-in-hand is no barrier to making profitable distinctions between them.

This section has aimed to provide a few clarifications about EC. In tracing the history of the debate a bit more, it has exposed the mistakes that EC is simply a conception of explanation as argument, or little more than the covering law model, or a conception of understanding. With these remarks and preliminaries in place, we now turn to elaborating the main argument for OC in order to further clarify the debate.

3. The Master Argument for OC

By December 1970, von Wright's Tarner Lectures, which were given in Cambridge the previous fall, had materialized into his *Explanation and Understanding*. The subject matter revolved around a distinction between teleological understanding versus causal explanation. Neither the lectures nor the book deliberately advanced any version of OC; indeed, it's unclear that the conception ever even occurred to von Wright. Curiously, though, *Explanation and Understanding* opens with the following example.

> [. . .] the explanandum is an event and the explanans consists of antecedent events and states. Why did the radiator of my car burst during the night? The tank was brim-full of water; the lid was tightly screwed on; no antifreeze liquid had been added; the car had been left in the courtyard;

---

11. See, for example, Ruben (1990: 6–7), Faye (1999), Woody (2004: 789), Lycan (2005: 408), Wright and Bechtel (2007: 51).

the temperature during the night fell unexpectedly to well below zero. These were the [causal] antecedents. [. . . T]hey explain the bursting of the radiator. (1971: 12)

von Wright's example was footnoted to suggest that it simply reprises an earlier version from Hempel (1942). Yet, von Wright misrepresented Hempel's original text by simply excising or otherwise ignoring Hempel's explicit and straightforward references to the representations of the causal antecedents that comprise the explanation—perhaps a mere lapsus calami, or perhaps just a bit of stylistic editing. It is historically interesting to consider whether OC originated from an exegetical shortcut, but logically fallacious to dismiss it on that basis. Von Wright's example, which was later rehearsed by Salmon (1989: 86), made available the thesis that the explanatory relation is a non-representational relation in re—a conception that appears in a few oblique remarks in Coffa's 1973 dissertation.

Still, OC is often said to have originated with Coffa in Pittsburgh in the 1970s.[12] However, Coffa wrote exceedingly little about OC, and most of what is ascribed to him originates from Salmon's testimonials: for example, 'Coffa often identifie[d] the explanans with what produced or brought about the explanandum', and again, 'Coffa [was] a staunch defender of the ontic conception of scientific explanation, and his theory of explanation reflects this attitude. An explanation of any occurrence is a set of objective facts and relationships. For Coffa, what explains an event is whatever produced it or brought it about.' (1989: 86, 133). Additional entanglements between Coffa and Salmon have further led commentators to dispute not only Coffa's role in the development of OC, but in the theory of explanation more generally.[13] Salmon's role, of course, is incontrovertible.[14] But the genesis of the ideas behind OC and direction of influence remain historically unsettled.

Conceptually, the ideas were nicely explicated by Forge (1993; 1998), but continue to require clarification. As Craver correctly notes, Salmon 'defended an

---

12. In his *Four Decades*, Salmon incorrectly attributed the distinction between EC and OC to Coffa at or around 1977, despite that he himself had already been expressing, years earlier, the claims he was attributing to Coffa: e.g., '[. . .] causal relations constitute the explanatory device' (1975: 126).

13. In some cases, the dispute is simply implicit, as when Coffa is altogether omitted from major treatises on causation and causal and probabilistic explanation (e.g., Humphreys 1989; Mellor 1995). In others, it is explicit, as when Coffa's contributions are suggested to have been misdescribed or exaggerated, owing in part to Salmon's inability to distinguish his own intellectual history from the historical record (Fetzer 1991: 288, 295).

14. While Salmon's role in the development of OC is incontrovertible, his own version of OC was beset by inconsistencies and conceptual difficulties, and ultimately may have just been an epistemic conception of causal explanation (see Wright 2015; Bokulich 2016).

ontic view, according to which explanations are objective features of the world'; and as he uses it too, '[. . .] the term *explanation* refers to an objective portion of the causal structure of the world, to the set of factors that bring about or sustain a phenomenon' (2007: 27). In a recent attempt to motivate OC, however, Kaplan and Craver offer the following sidelong rehearsal of it:

> English speakers also use the word "explanation" to refer not to a model but to the thing in the world that "explains" (in an ontic sense) the phenomenon in question. The claim that global warming explains the rise in sea levels is not about a model or a representation; it is about the rise in mean temperatures and its causal relationship to sea levels. From this ontic perspective, models are tools for representing objective explanations. (in press: 16)

A puzzling feature of this passage is their deliberate use of scare quotes around the term *explains* in the first claim, as if to distance themselves from Craver's (2007; 2014) assertions of ontic explanations being philosophically serious. Another is the thought that some speakers sometimes equivocate over different senses of *explanation* by using it to refer to ontic explanations, given that it's made trivially true by every proponent of OC who uses that term in that way—Craver, of course, being one such speaker. More problematic is the prevarication in the second claim; for the issue is not whether the expression *global warming explains the rise in sea levels* is about a model or a representation (something that presumably no one holds), nor whether the expression is about the rise in mean temperatures and its causal relationship to sea levels (something that presumably everyone holds). Those are irrelevant red herrings. What proponents of EC deny is that such expressions are true, because they deny that epistemic acts of explaining are performed by rises in mean temperatures; and what they assert is not that such expressions are about models or representations, but that explanations are representations. Consequently, rather than clarifying and motivating OC, Kaplan and Craver offer up a trivially true claim and an irrelevant claim; and the third of those three claims turns out to be a mere restatement of OC rather than a reason to think it's true.

Because explanations, especially very complex ones, are not nakedly observable in the way that some simple objects and property instances are, it's not unreasonable to begin with what is empirically manifest: speakers and speech. What proponents of OC have attempted to do is derive substantive metaphysical conclusions about the nature of explanation from premises about pragmatic usage of words like *explain* and *explanation*. Their master argument has two main inferential steps. The first step involves demonstrating that the term *explanation* has multiple senses. The second step involves demonstrating that, given the

multiple senses of *explanation*, actual explanations are ontic. Once combined, the argument is as follows:

    (1) Speakers equivocate over the term *explanation*.
    (2) Speakers equivocate over the term *explanation* only if the *explanation* is ambiguous.
∴(3) The term *explanation* is ambiguous.
∴(4) The term *explanation* has multiple senses.
    (5) Of these multiple senses, one philosophically legitimate sense of *explanation* is the ontic sense.
    (6) All other non-ontic senses of *explanation* mean explanatory texts.
    (7) Explanatory texts are not actual explanations, but representations of them.

∴(8) Actual explanations are ontic.

Crucial to note is that no one impugns the first step of the argument. As we have already seen, some speakers do indeed equivocate; and so premise (1) is not false. Indeed, most proponents of OC have been perfectly sanguine about resorting to descriptions, depictions, models, and other representations when discussing how phenomena are accounted for. (As proponents of EC are quick to note, this is because *explanation* is an epistemic success term.) Additionally, in equivocating over it, the equivocation itself then becomes evidence that the term *explanation* is ambiguous; for one can equivocate only where ambiguity exists.[15] Consequently, all parties to the debate also accept that premise (2) is true, and, consequently, that the inference from (1) and (2) to (3) is sound.[16] And (4) is just a vestigial premise directly implied by the truth of (3).

The semantic hypotheses in (3) and (4) must be handled with care, however, since they do not weigh in favor of any particular conception. Independently of premises (1) and (2), the term *explanation* has multiple senses conforming to both process (e.g., *her long-winded explanation took a full seven minutes to convey*) and product (e.g., *the explanation is complicated*), and there are multiple senses if by *explanation* one may mean teleological explanation here, or statistical, causal, etc. explanation there, or theoretical or model-based, case-based, etc. explanation here and there, and so forth. Yet, if anyone can accept that much, any proponent of EC can too.

Consequently, the core issue is not, as some seem to have previously sug-

---

15. That is, in the very act of stating their position, proponents of OC create the ambiguity needed to claim that the term *explanation* is ambiguous with an ontic sense.

16. This important point is sometimes overlooked. Şerban (2017), for example, interprets Wright (2012) as claiming that *explanation* is not ambiguous, and thus as denying premise (3); we interpret him as instead claiming that '[. . .] *explanation* is not ambiguous in the way assumed by, and required for, OC' (2012: 277), which is consistent with (3).

gested, over whether *explanation* is or is not monosemous or otherwise unambiguous in a way that would render either (3) or (4) false. Rather, the core issue is whether, given (3) and (4), *explanation* is ambiguous in a way that would render (5) true. In recognizing this much, what one recognizes is something that has not been clear in the literature on explanation: the legitimacy of an ontic sense of *explanation* is not automatically sanctioned by that term's ambiguity. Whether or not (5) is true, there is no valid inference from any of (1)–(4) to it. To make it valid, advocates of OC would need to add a further premise. But which suppressed premise is that?

Consequently, the two main steps of the argument can be inferentially disconnected. This observation has an important implication: none of the difficult work in establishing the argument is ultimately done in the first step. All of it occurs in the second step to follow. That's not to say, of course, that the master argument cannot still establish OC. But it can do so only if there were an additional and compelling reason to assert (5), independently of the first four premises.

We have already seen what proponents of OC appeal to: there exists a class of ordinary language expressions with the surface appearance of ontic explanations, such as *the tumor explains the radiation* or *the trefoil knot explains the failure to untie it*. Call them ir-expressions (for *in re*). Plainly, ir-expressions cannot themselves be ontic explanations, on pain of contradiction. But they are supposed to be collectively symptomatic of some profound truth within the metaphysics of science about the mind- and representation-independent nature of explanation; and so appeals to them, as a reason for asserting (5), have routinely accompanied nearly every attempt to advance OC. For instance, in his *Four Decades*, Salmon recited it thus:

> [i]n non-philosophical contexts however, it seems entirely appropriate to say such things as that the gravitational attraction of the moon explains the tides, or the drop in temperature explains the bursting of the pipes. The gravitational attraction and the drop in temperature are out there in the physical world; they are neither linguistic entities (sentences) nor abstract entities (propositions). (Salmon 1989: 86)

Of course, with Salmon, anyone can agree that the felicity of ir-expressions is perfectly normalized in certain non-philosophical contexts: it may indeed be entirely appropriate to say such things as *the moon explains the tides*.[17] But this is only for the pragmatic sake of expressive simplicity. Indeed, for many ir-expressions,

---

17. As Wright (2012: 380, Footnote 7) noted, Salmon's passage is beset by a non-sequitur: the material issue is not about whether gravitational attraction or temperature changes are 'out there in the physical world' (where else would they be?), but about whether or not explanations are located amongst them.

the sense in which they are merely façons de parler is quite overt. The non-philosophical contexts in which they are held to be appropriate are also those same contexts in which it is said that the ham sandwich left without paying, that electrons and markets desire stability, and that the broken windows explain the crime rate.

In a prescient observation anticipating this point, Collins (1966) observed that instances of the schema,

(9) *c* causes *e*,

are such that, in appropriate contexts, reference to or citation of *c* will explain *e* and it will be felicitous to utter instances of

(10) *c* explains *e*.

As Collins noted, though, this is not interestingly different from the observation that

(11) if a subject S can open a door by using a certain key, then we can say, 'that key opens the door',

or more generally,

(12) if appeal to or use of *x* is a means by which S can get *y* done, then speaking figuratively we can say, '*x* gets *y* done'.

As Collins remarks, just as 'the key does not open anything until someone uses it', the cause of the event does not explain anything until someone acquainted with it invokes it to explain the event to herself or to others (1966: 484). To take a more scientific example, dogs that suffer from renal necrosis may ingest grapes; and dogs which ingest grapes may suffer from renal necrosis. Both are low probability event types, though the latter involves a causal relationship that renders utterances of *the grapes explain the kidney failure* (pragmatically) felicitous in the context of communicating correct medical diagnoses or answering how-, what-explains-, or why-questions. There is no confusion about whether grapes interact with kidneys in canine bodies, though, or whether grapes perform acts of explanation while passing through the esophageal tract, or whether explaining is part of the behavioral repertoire of grapes more generally. Rather, it's just that the clinical pathology designated by the term *failure* involves complex biochemical mechanisms of toxicosis, the causes of which have unfortunately proven recalcitrant to scientific investigation and which are described using synecdoche and

personification (*the grapes explain*) for ease of communication.[18] There is nothing particularly profound or mysterious about these oft-used linguistic techniques: language is quick and dirty and built for speed.

Consequently, it is not obvious that philosophical conceptions about the nature of explanation must be beholden to this kind of ordinary language data in the first place. And given that not all data counts as evidence, proponents of OC need yet a further reason for thinking that such expressions can do the justificatory work asked of them. For Jenkins (2008: 65), the reason is that common sense sanctions the assumption that anything which is frequently labeled *explanation* just is one. But that straightforwardly begs the question. Appealing to the existence of ir-expressions, being no less controversial than the premise it seeks to justify, is not a compelling reason that establishes the philosophical legitimacy of the ontic sense of *explanation*.

Prima facie, proponents of EC and their opponents can agree that i-expressions are data that count as evidence of the fundamental metaphysical nature of explanation only if those expressions are themselves true. But this would require ir-expressions to be reinterpreted literally if they are to count as evidence (since they would not otherwise be truth-apt). And here, again, proponents of OC will once more need yet another independent reason or argument to motivate this assumption. Moreover, even if ir-expressions should be reinterpreted literally, why think that they would turn out to be true? This point is nicely brought out by an example from Ruben:

(13) The hurricane explains the loss of life.
(14) The hurricane is the event reported in *The Times* on Tuesday.
∴(15) The event reported in *The Times* on Tuesday explains the loss of life.

who noted that the conclusion in (15) might come out true only if reinterpreted so as to imply that there is an explanation of the explanandum event that involves—when differently described—the event denoted in (13) (1990: 164). But as described, (15) appears to be a literal falsehood, in which case premise (13) would be too.[19] As he put it, '[t]he best diagnosis of what has gone wrong is that,

---

18. The phenomenon is more commonly described by *anthropomorphism* than by *personification*. Because the scholarship on these literary or rhetorical devices is unprincipled and the distinction insufficiently rigorous (and does not track the distinction between humans and persons), we ignore their differences here.

19. The same problem can be brought out using Jenkins's (2008: 64) example, *Smith's broken steering wheel is the explanation of his car crash*, as an illustration of OC. However, *Smith's broken steering wheel explained his car crash* is literally false, given that broken steering wheels are constatively inert. Since logically equivalent expressions should have the same truth-value, either the expressions are not equivalent or cannot be reinterpreted as literally true.

despite appearances, the first premise of each argument is not transparent, not to be construed as stating that a relation obtains between two events [. . .]. One should take the falsity of the conclusion to throw doubt on the conception that particular events (or states, or whatever) can transparently explain events' (1990: 162). With Collins and Ruben, proponents of EC conclude that the predicative terms of ir-expressions do not transparently designate a natural relation of ontic explanation.

Even if ir-expressions were reinterpreted literally, and even if there were good reasons for thinking they could turn out to be true, additional problems wait in the wings. If ordinary language in non-philosophical contexts becomes the standard of acceptability among metaphysicians of science, then one good distinction deserves another. In those contexts it is said that a Kepler orbit describes the motion of an orbiting body, and a protein's primary structure describes the type and sequence of covalently linked amino acids in a polypeptide chain. But then there's no non-arbitrary reason to insist on the distinction between explanations in re and explanatory texts while rejecting the distinction between descriptions in re and descriptive texts. And the latter distinction is preposterous.[20]

To summarize, while the inferences from (1) and (2) to (3), and then to (4), are sound, there is no valid inference from any of (1)–(4) to (5): *explanation* is ambiguous, but it does not follow that it is ambiguous in the way assumed by, and required for, OC. Because the legitimacy of an ontic sense of *explanation* is not automatically sanctioned by that term's ambiguity, the master argument for OC could establish it only were there compelling reasons for asserting (5). Proponents of OC appeal to ordinary language ir-expressions. However, these expressions are elliptical figures of speech that, when reinterpreted literally, are not true and do not transparently designate a relation of ontic explanation. So, that data is not evidence for thinking that there is a philosophically legitimate ontic sense of *explanation*; and with no compelling reasons for asserting (5), the assertion of it looks question-begging.

What of the rest of the argument? Recall that premise (1) is made true by the fact that proponents of OC sometimes equivocate (perhaps not unintentionally). As Bokulich (2016: 266; see also Wright 2012: 379, Footnote 6) observed, proponents of OC have difficulty with what she calls 'doublespeak': that is, expressing themselves both consistently and naturally, while holding fast to OC. To navigate this issue, proponents of OC have deployed an important distinc-

---

20. Applied to this example, Illari's (2013: 243) criticism would appear hostage to the Humpty Dumpty theory of language: if speakers opt to use *description* to mean description in re, nothing prevents them from paying that word extra. Typically, though, the norms governing good description and the good use of *description* stand, or have great falls, together. (Mutatis mutandis for the term *explanation*.)

tion between explanations and texts.[21] According to this distinction, explanations are ontic; texts are epistemic. The former are mind-independent and non-representational denizens of nature, like force, matter, causal process, event, and the like; the latter are denizens of culture, like descriptions, depictions, diagrams and other conventional and symbolic representations used in scientific practice.

This distinction between explanations and texts offers proponents of OC not only a handy device for disambiguation, but also a principle upon which to assert premise (6). Premise (6) is otherwise underived; and indeed, there is no valid inference from any of (1)–(5) to it. Were premise (5) just granted, the philosophical legitimacy of the ontic sense of *explanation* would not be, by itself, sufficient to warrant thinking that that sense is primary or fundamental, or that actual explanations are ontic; for it remains a possibility that all non-ontic senses of *explanation* also mean explanation (rather than derivative text), or that all senses are equifundamental. While premise (6) functions as an underived, stipulative definition independent of its predecessors, it does not operate as a stand-alone premise. Coupled with (6) is premise (7), which originates from Salmon's assertion that,

> [a]n explanation of any occurrence is a set of objective facts and relationships. For Coffa, what explains an event is whatever produced it or brought it about. [. . .] The linguistic entities that are often called 'explanations' are statements reporting on the actual explanation. (1989: 133)

which was later repeated by Craver:

> Good mechanistic explanatory texts (including prototypes) are good in part because they correctly represent [actual] explanations. Complete explanatory texts are complete because they represent all and only the relevant portions of the causal structure of the world. Explanatory texts can be accurate enough and complete enough, depending on the pragmatic context in which the explanation is requested and given. [Actual] explanations are not variable in this way. (2007: 27)

More than just a rehearsal of Coffa's thesis that actual or real explanations are explanations in re, Salmon's deployment of the distinction is rhetorically shrewd

---

21. Craver wrote, '[a]t times, I will switch back to using the word *explanation* to describe explanatory texts or explanatory models' (2007: 27, Footnote 3). But the entirety of the reason for making this distinction was to have a term, *text*, which would allow *explanation* to unambiguously mean actual (i.e., ontic) explanation. To the extent that proponents of OC maintain the doublespeak they trespass against their own distinction; and in doing so, premise (6) cannot be upheld. The knock-on effect is that the inference to the main conclusion for OC in (7) would be undercut.

because it ultimately grants proponents of EC their interest in representation while stealing away with the concept ExPLANATION.

Premises (6) and (7) form the lynchpin of the argument for OC, and only together can they reach the conclusion. But the distinction between explanations and texts is not some sine qua non of theory construction, and since proponents of EC cannot readily accept it (on pain of self-refutation), their opponents need to motivate premises (6) and (7), not just assert them. Yet, the only thing that could ultimately justify (6) and (7) is an ideological commitment to OC. So, there seems to be no good grounds for thinking that proponents of OC could have a good reason that is not, again, immediately question-begging; and this is itself grounds for thinking that they don't.

To sum up: according to OC, actual explanations are ontic only if they are non-representational physical entities in re—items in the realm of referents rather than reference, if you like. Unfortunately, the master argument for OC does not establish the plausibility of its central thesis that actual explanations are ontic. But even if it did, there is another telling case for thinking that support for OC is overblown. Proponents construe ontic explanations as cases of singular causation, but this construal precludes OC from making sense of most scientifically interesting and important explanations. This point is argued next.

4. Ontic Explanations as Instances of Singular Causation

Scientific explanations routinely abstract away from details about their target explananda; and more than that, they should, in so far as details differ in their pragmatic and explanatory relevance. For example, neuroscientists have a vested interest in learning how the brains of Sprague-Dawley rats work; but what they learn, if they learn it, is content that is overwhelmingly concerned with only certain types of structures and processes, such as neurons and neurotransmission; in so learning about how Sprague-Dawley rat brains work, neuroscientists often abstract away from the details of other types of structures and processes in the brain, such as Schwann cells and other glia, prions, lymph vessels below the dura mater, and so forth. Doing so allows them to focus on topics of greater concern: perception, emotion, cognition, motor planning, and the like.

Generalization is another important norm or constraint that good scientific explanations routinely satisfy. Often these norms work together, as when explanations 'ascend' to event types (abstraction) and then 'transcend' across them (generalization). Once at the level of the canonical cell membrane, textbook illustrations of the sodium/potassium pump, the action potential, etc., scientists routinely try to fit what they know about neurotransmitter release in, for example, the Sprague-Dawley rat brain to Wistar rats and Swiss-Webster mice, as well as to

leech ganglia, human brains, and so forth. Increasingly general explanations are a central route by which scientific principles and theories are prosperously unified.

The satisfaction of these and other norms and constraints indicate that scientific explanations of phenomena are not case studies in tokening. To take another example, while excavating token cadavers has played an important pedagogical role in the education of legions of medical students, the scientific explanation of heart disease is not an ontic explanation residing in a single token chest cavity. Wright (2015) has already laid out the reasons why Salmon was mistaken to think that, for example, showing or presenting a token heart and following the evolution of its pathology over time would count as an ontic explanation. But even if it were to count, any such ontic explanation would stop far short of an explanation of heart disease tout court (as opposed to, e.g., Smith's or Jones's heart disease). While not to diminish the ways in which the painstaking study of, for example, an individual token entity might be important for developing evidence, scientists aggregate the results of any such studies of concrete particulars and the token events they participate in; and their explanations are sophisticated animations, diagrams, simulations, and other models that abstract away from many specific details of many individual hearts (yours, mine, hers, . . .), and generalize across many different types of hearts, from within a subspecies to across different species (pigs', mice's, humans', etc.).[22] Good scientific explanations, whether of action potentials or heart disease or anything else, will nearly always be explanations of types of phenomena.

How can these observations about norm-governed explanatory practices be squared with OC? For its proponents, actual explanations are the concrete particulars spatiotemporally localized in the actual world, whose representation-independent existence, properties, and causal powers explain various phenomena in virtue of causing or producing them. In an excellent paper on mechanistic causation and explanation, Glennan (2011: 808ff.; see also Hausman 2005) convincingly argues that mechanisms are particulars rather than universals, and thus that mechanistic accounts should be wedded to singular causation. As Illari and Williamson put it, ontic or 'physical explanation' is local to the phenomenon produced, and individuated by the parts organized to produce the phenomenon (2011: 827). Of course, subsequent debates over how best to understand the mechanistic account reside a bit downstream; but for those advocates of mechanistic accounts who also claim that actual explanations are ontic, mechanistic explanations are likewise just the localized concrete mechanisms that mediate particular causes.

---

22. Sheredos (2016) argued that the demand for generalized explanations undermines the normative priority of ontic constraints. We agree, but are here arguing for a different, more penetrating criticism of OC: the demand for generalized explanations lands OC in a dilemma in which being ontic trades off against being explanatory.

Proponents of OC have illustrated these views with several examples. We have seen von Wright's radiator example (see §3), which bound the concept of explanation to that of causal antecedents and property instantiation. Better, there is also a nice example of Salmon's own making, which Craver later rehearsed as well:

> Suppose that a counter detects 99% of the impinging photons, but never mistakenly registers something when no photon is present. A photon is necessary but not sufficient for a click of the detector. I claim that, when a click occurs, it was caused by an impinging photon and the impinging photon explains the click. (Salmon 1985: 652)

> Instead, [Salmon] defended an ontic view, according to which explanations are objective features of the world. [. . . T]he term *explanation* refers to an objective portion of the causal structure of the world, to the set of factors that bring about or sustain a phenomenon (call them objective explanations). What explains the accident? The ice on the road, the whiskey, the argument, the tears, and the severed brake cables. What explains the release of neurotransmitters? The action potential, Ca2+ influx, vesicular binding, and fusion. (Craver 2007: 27)

In each example, the particular events to be explained (the detector click, the accident, the transmitter release) are causally related to various other such events, concrete particulars, substances, etc. Myriad other examples follow suit: for example, the actual explanation of the 2010 BP oil spill in the Gulf of Mexico just is the (lack of) participation of a unique physical structure (i.e., the blowout preventer) in a dated event (its failure to engage on April 20th 2010) in the causal structure of the physical world. The failed blowout preventer explains the spill. All told, these examples further indicate what proponents of OC ultimately have in mind: ontic explanations are cases of singular causation—token occurrences of an event 'explained' by singular causal interactions.

One interesting consequence is that there will be as many examples of ontic explanation as there are token causes. This consequence accords well with OC's general conception of ontic explanation being superimposed onto causation; as Salmon put it, OC aims to 'put the "cause" back in "because"' (1977: 215).[23] An-

---

23. Bokulich (2018: 4) demonstrates that the substitution of causal talk with an ontic sense of *explanation* results in incoherence, raising doubts about the feasibility of identifying or even just superimposing explanation and causation. Most philosophers of science suppose that the explanatory relation often tracks the productive relation, but not vice-versa; yet, the identity of ontic explanation and singular causation would imply the converse as well, given the symmetry of identity. It

other interesting consequence, however, is that the relata of these token causal relationships cannot be abstracta or genera; for abstracta and genera do not have causal powers—the very causal powers that would be necessary for them to serve as the explanantia of ontic explanations. The class of hammering-events pounds no nails. Or again, to take Craver's own example: token action potentials may causally factor in some particular neurotransmitter-release events, but the general form of the action potential, especially as represented in textbooks, does not causally produce the token events instantiating it. The tokening of that type is a synchronic, non-causal relationship.

In Section 3, the master argument for OC was shown to have several flaws. But even if it were perfectly sound, the construal of ontic explanations as cases of singular causation introduces a serious problem. Scientific practice relies heavily on the use of abstraction, idealization, and generalization, and the explanations that result from these practices routinely involve abstractions or generalizations across types or classes (of the sort picked out linguistically by habituals, repetitives, plural generics, and similar other kinds of finite clauses). Indeed, the explanations that matter most to the scientific community are those implicating classes of activities or events, kinds of mechanisms, types of causal processes, and so forth. This is an old point, really, having been made by Salmon himself:

> Arguments by Greeno [Alston, etc.] have convinced me that explanations of particular events seldom, if ever, have genuine scientific import (as opposed to practical value), and that explanations which are scientifically interesting are almost always explanations of classes of events. (1975: 119)

The irony, however, is that Salmon's acknowledgement that particular events seldom if ever have genuine scientific import trades off against OC's core examples of ontic explanation, which, again, are cases of singular causation: the burst radiator, the impinging photon causing the click, the failed blowout preventer causing the spill, or the frozen O-rings, the severed brake cables causing the accident, or the whiskey or broken steering wheel, etc.

So, OC appears caught in a dilemma. If explanations must generalize or abstract away from the details of singular causation to have genuine scientific import or interest, then, pace Salmon, explanations cannot be ontic. But if they are ontic and so cannot involve abstracta or genera, which have no causal powers, then those explanations will be without genuine scientific import or interest. Consequently, on OC's own terms, it seems that scientific explanations can be

---

would also require proponents of OC to address the issue of 'negative' causation (e.g., if the failed blowout preventer ontically explains the spill, it causes it by omission).

ontic or explanatory, but not both. The problem may even be worse: the fact that scientifically interesting explanations are almost always explanations of classes of events is easily accommodated by EC.

This dilemma could be dissolved were there no durable relationship between explanations that are scientifically interesting and important and explanations of classes of events. But we shouldn't hold our breath; for Salmon was right to be persuaded, and the suggestion that there is such a relationship is, again, constantly confirmed. The failure of Smith's pancreas, for example, will be notable in diagnosing Smith with diabetes mellitus, but it won't do as a scientific explanation of the metabolic regulation of blood sugar. For a more scientific example, take instead a unique collision between particular proton-beams, which are part of the causal etiology of the decay signature of (what was) a single extant Higgs-boson particle with a mass of 125.3 ± 0.6 GeV. That's a far more newsworthy event with enormous practical, ontological, and historical value. However, its newsworthiness is qua scientific discovery, and discovery and explanation are vastly different issues. For explanatory purposes, what's of scientific import and interest is the generalization over numerous such collisions from June 22nd 2012 to March 14th 2013, whose explanandum is the class of Higgs-boson decay events that provided the crucial causal evidence for this type of particle. The explanans itself is, or consists in, an abstract representation of a kind of mass-generating mechanism in which elementary particulate matter generally acquires mass by interacting with the scalar Higgs field. The relata of any such token causal relationships won't be the kinds of abstracta or genera that feature in scientific explanations, and neither will those abstracta or genera be the relata of ontic explanations.[24]

Why can't proponents of OC just revise their conception so as to affirm the role of abstracta, genera, and other typological structures in genuinely ontic explanations? Only if they aren't cognitive structures could abstracta be non-representational and mind-independent ontic structures with causal powers to produce events as required by OC. But abstraction is a cognitive process characterized by focal adjustments of deselection. And since the relata of cognitive processes are themselves cognitive structures, it follows that abstracta aren't non-representational and mind-independent ontic structures with causal powers to produce events per OC.

---

24. Glennan's more recent views, as expressed in *The New Mechanical Philosophy*, seem to support this argument. He supposes that abstractions and generalizations help scientists transition from studying particular ontic structures to producing general scientific explanations of mechanistic types. More specifically, he also affirms that explanations involve 'the inevitable abstractions and idealizations that help us find generality in a world of mechanisms that are ultimately particular, localized, and heterogeneous' (2017: 83). Such passages suggest how to pair a mechanistic account of particular systems that are themselves real and local and mediate singular causal interactions with an epistemic conception of explanations that are themselves abstract and general representations aimed at de re knowledge.

Why can't proponents of OC just revise their conception so that singular causation is unnecessary for ontic explanation, or so that they are explicitly committed to general causation? For example, consider the explanation of causal or statistical relationships between smoking and pulmonary emphysema, or the buildup of amyloid plaques and Alzheimers: *incessant smoking causes pulmonary emphysema*, or *the buildup of amyloid plaques causes Alzheimers disease*, one might assert. Here, the causal relationship is general, and the putative explanantia are process types, event kinds, etc. But as Mellor (1995: 7; see also Hausman 2005; Glennan 2011) reminds us, the distinction between general and singular causation does not imply a concomitant distinction between general and singular causes and effects; for general causation is just a generalization of singular causation, the relata of which remain token causal interactions, tropes and property instances, and the like. Incessant smoking generally causes pulmonary emphysema if and only if incessant smokers' emphysemas are generally caused by their incessant smoking.[25]

Why can't proponents of OC just deny that problems involving idealization, abstraction, and other alethic and typological norms fit the scope of their conception? Abstraction, generalization, and idealization are used in the service of constructing explanatory representations that articulate explanatorily relevant factors (given a specific explanatory request), and the representations that result from these practices aim at norms or constraints on the goodness of explanatory representations. So, it's hard to see how they could be forced to fit. Proponents of OC tend to agree. For instance, Craver reprises his earlier claims to this effect, suggesting again that it is inappropriate to talk of ontic explanations as being more or less accurate, idealized, or abstract, given that they 'just are' entities in the world:

---

25. We acknowledge that there may be responses open to OC, which have yet to be fully articulated. For example, some proponents of OC may have prior commitments to either general causation or fact causation. If those commitments can be made persuasive, the arguments in this section may need to be suitably restricted. But those commitments are not cost-free. Proponents of OC with commitments to general causation may have to renege on their inheritance of OC from Salmon, being unable to rely on his body of work on, e.g., mark transmission and token physical processes as an expression of their views. They would also have to reconcile their pursuit of this option with giving up on the variety of examples of singular causation from Coffa, von Wright, Salmon, Glennan, and Craver used to motivate OC. Proponents of OC with commitments to fact causation would also need to supplement their views with a non-deflationary metaphysics of facts (construed compositionally, since facts could not be construed propositionally and still be consistent with OC), as well as a nuanced account of negative causal facts regarding omissions, inhibition, and absences, disjunctive facts, and conditional facts, and so forth. Although replacing commitments to singular causation with general or fact causation will come with these and other new problems, and is unlikely given the background commitments of most proponents of OC, these options should not be dismissed out of hand; while proponents of OC haven't (yet) shown willingness to pursue them, they are certainly open for exploration.

> Terms like *true*, *idealized*, and *abstract* apply to representations or models. They do not apply to the ontic structures they represent (bracketing cases in which the ontic structures involved in the explanation are themselves representations). Once these are separated, the problem of idealization is clearly not a problem for philosophical theories of explanation; rather it is a problem for philosophical theories of reference. (2014: 50)

Although proponents of OC seem wary of linguistic prescriptions, Craver's prescription here about the proper uses of predicates like *true*, *idealized*, and *abstract* does seem to be on solid footing. And it is well-motivated by OC's inability to handle explanations involving idealized, abstracted, or generalized entities (cases that, again, EC has no problem accommodating, given that it does not recognize the distinction between actual explanations and texts; see van Eck 2015; Bokulich 2016: 262–268; Sheredos 2016). However, Craver's suggestion offers no shelter for proponents of OC; for again, the material issue is not whether such predicates do or do not apply to ontic structures. Rather, the material issue is whether those ontic structures just are explanations to which predicates like *true*, *idealized*, and *abstract* do not apply. Proponents of OC believe so, but as we have seen in these sections, their arguments are on shaky ground.

5. The Normative Shift toward the Ontic Constraint View

In the first two chapters of *Explaining the Brain*, Craver asserts that explanations are ontic, and that ontic explanations aren't good or bad, and that one of his main projects is to clarify the norms of good and bad explanations. But how can these three claims comport with one another? If actual explanations are ontic and ontic explanations aren't good or bad, then there seem to be no norms of good and bad explanations to clarify; if actual explanations are ontic and there are norms of good and bad explanations to clarify, then it appears that ontic explanations are good and bad after all; or, if ontic explanations aren't good or bad but there are norms of good and bad explanations to clarify, then it would seem that actual explanations aren't ontic.

What appears to be an inconsistent triad can be resolved by redeploying the explanation/text distinction in premises (6) and (7), such that the phrase 'norms of good and bad explanations' is just read as meaning the norms of good and bad explanatory texts. However, it may not be this easy. As mentioned in Section 3, those premises are question-begging; the main thing that could justify them is an ideological commitment to OC. And even if they could be justified, the assimilation to singular causation suggests that what's scientifically interesting

and important for explanatory practice are not ontic explanations, as discussed in Section 4.

Given these and other difficulties, it is unsurprising that OC has been under pressure to evolve. The most notable effort to facilitate this evolution comes from Illari's proposed 'normative turn'. Illari declared that the debate between these two conceptions is unproductive (2013: 240; see also Sheredos 2016: 924, Footnote 8), and then suggested that the way to move it forward is just to abandon attempts at answering the question *what are explanations?* and instead turn toward the question *what normative criteria demarcate good explanations from bad?*

We support Illari's attempt to move the debate, even though it prematurely left several issues unaddressed. One issue not considered is whether these two questions must be dealt with sequentially. If so, then abandoning the first question in order to take the normative turn looks like a mistake, much as it would be a mistake to try to demarcate all and only the good apples from the bad without first knowing what apples are. But if not, then it is unclear why one question has to be abandoned in favor of the other, or why they can't both be answered in parallel. Another issue not considered is whether the debate between OC and EC, far from being unproductive, has already been resolved.[26] We think so. Before arguing for this consideration, let us briefly canvass this 'normative turn'.

Proponents have construed the normative turn as a way of salvaging or developing OC through what has come to be called the 'ontic constraint' account. According to this account, epistemically conceived explanations are normatively constrained by the entities that they represent, and are good explanations only in so far as they accurately represent the ontic entities they target. This much is not new, of course. As Glennan remarked almost three decades ago,

> [a]lthough the choice of decomposition is dependent upon the capacity to be explained, decompositions are not merely artifacts of the description. Veins and lungs are both really parts of human bodies, even though they overlap. Descriptions of mechanisms are good descriptions insofar as they describe what is 'really' there. (1992: 25)

One would be hard-pressed to disagree with the thought that the goodness of (mechanistic) descriptions is constrained by what's being described. Of two otherwise identical explanations of ϕ, one that represents ϕ aright and one that does not, we should have a ceteris paribus preference for the former. But this thought seems to be little more than the truism that explanations should accurately be

---

26. One bit of evidence is that proponents of OC continue to distance themselves from it. For example, Craver's (2016) discussion of network explanation gives up on Craver's (2014) defense of genuinely ontic explanation.

about the real-world entities they are about—a thought too thin to be useful to proponents of OC; for the platitude that good explanations depend on what there is and how things are is itself little more than a variant on the more general platitude that the world co-determines truth-value. As Wright put it, 'use of the predicate *represents certain ontic structures* is just code for saying little more than that representations are directed at things in the world—an "ontic constraint" that is already built in to any epistemic conception taking explanation to be even weakly or quasi-factive' (2015: 29). Consequently, ontic constraints on explanations are unmasked as being just a subset of the familiar alethic and epistemic constraints on world-directed representations.

What is new, and what gives the ontic constraint account some bite, are its further claims about priority. Proponents of OC also suggest that ontic constraints are the most fundamental normative constraints on explanatory representations. Hence, Craver asserted that '[r]epresentations convey explanatory information about a phenomenon when and only when they describe the ontic explanations for those phenomena' (2014: 28). Kaiser (2014), Halina (2015), and others adopt this perspective, arguing that ontic constraints have priority over others: descriptions are taken to be explanatory only because they communicate information about the real-world explanation. However, such claims have met with challenges. For instance, as van Eck (2015) has countered, epistemic constraints are fundamental since the discovery of ontic structures—an epistemic and inferential process—is prior to and required for the construction of explanations. Ontic constraints can only be meaningfully satisfied once the epistemic discovery work has been done.

The debate over priority might shake out in various ways. For present purposes, the important point is that shift toward inquiry into normative constraints risks signaling that what has been abandoned is not, as Illari and Sheredos suggested, the debate between EC and OC, but just OC itself. To conceive of explanations as entities that can satisfy ontic constraints or norms as a measure of their goodness just is to conceive of explanations as representational entities. But any such conception will be inconsistent with premises (6) and (7) of the master argument for OC (Wright 2015: 29; Bokulich 2016: 267). In other words, proponents who turn to the ontic constraint account risk leaving OC in an unstable position; for rather than just turning away from an unproductive debate, the ontic constraint account is instead a concession of that debate to EC. Indeed, if they are right that the normative turn is a turn toward the productive debate, they will also be right in thinking that the productive debate concerns normative constraints on explanations, epistemically conceived.

The lesson that the ontic constraint account is unable to remain neutral on OC itself is exemplified by Glennan's recent work on mechanistic explanation. A project of his *New Mechanical Philosophy* is to account for different aspects of

successful scientific representation, one aspect being ontic and another being epistemic. In expounding his multi-aspect approach to explanation, Glennan writes that, '[t]o recognize the epistemic aspect of explanation is to recognize that explanation always requires representation' (2017: 222). The conception of explanation advertised in *The New Mechanical Philosophy*, as well in Craver's (2016) recent work on network explanation, is an epistemic one. But where does that leave OC?

6. Conclusion

The debate between EC and OC is a debate over how to conceive of the nature of explanation. Historically, most philosophers of science have endorsed some version of EC, which is a conception that presumes explanations to be complexes of representations about entities in the physical world that aim at increased explanatory knowledge. Versions of EC take the norms of explanatory goodness to be the norms of knowledge. In so far as knowledge is both factive and intentional, the intentum of which are just the ontic entities (states, events, systems, facts, etc.) so known, every version of EC will imply that explanatory knowledge satisfies ontic constraints; and so any version should be able to accommodate the basic suite of claims about alethic realism and the objectivity of explanatory knowledge. Still, proponents of OC have summoned philosophers of science back to the task of a priori conceptual analysis by disputing the central presumption of EC. In our opinion, being brought back to the 1960s-era of general philosophy of science is a step backward. However, a cracked foundation cannot be ignored.

This paper adds to the current literature by presenting three new interrelated arguments further demonstrating that OC is inferentially and conceptually incapacitated, and in ways that square poorly with scientific practice. In Section 2, we clarified EC by noting some of the mistakes involved in oversimplifying it. In Section 3, we articulated the master argument for OC, which attempts to establish that actual explanations are ontic and that epistemic representations are not actual explanations. Because the master argument fails, philosophers of science have no good reasons to override their prior presumption that construes actual explanations epistemically. In Section 4, we observed that the main thrust of OC is a conception that superimposes ontic explanation onto cases of singular causation, and thus leaves OC unable to accommodate scientifically interesting and important explanations that invoke abstracta and genera, which is, at a minimum, most of them. This lands OC in a dilemma—one which pits being ontic against being explanatory. In Section 5, we responded to a recent attempt to salvage OC by reframing it in terms of 'ontic constraints'. The ontic constraint ac-

count presumes that actual explanations are epistemic; but then, appeals to ontic constraints just concede the debate. Proponents of OC who take the 'normative turn' are therefore implicitly committed to declaring that the productive debate concerns constraints on actual explanations, epistemically construed. So, switching to the ontic constraint account does not deliver anything of importance not already delivered by EC. And EC does deliver something that OC does not: a conception that makes sense of explanatory practice, that avoids having to treat figurative and elliptical ir-expressions as literally true, and that does not require treating explanations as cases of singular causation.

Refocusing on constraints is a helpful entrée into thinking about explanation. We agree with Bokulich (2018: 4) that philosophers of science should set for themselves the task of clarifying the norms or constraints on good explanations. But this task will inevitably require clarity on the concept of explanation itself, that is, the concept of the sorts of things to which those norms or constraints are applied; for one cannot engage in focused analysis of the characteristics that certain things should embody or satisfy when one remains in the dark about the nature of those things. Fortunately, the epistemic conception is more or less the only game in town, and the only one we need.

Acknowledgements

References

Achinstein, Peter (1983). *The Nature of Explanation*. Oxford University Press.
Bechtel, William (2005). Explanation: A Mechanistic Alternative. *Studies in the History and Philosophy of Biology and Biomedical Sciences, 36*(2), 421–441. https://doi.org/10.1016/j.shpsc.2005.03.010
Bechtel, William (2008). *Mental Mechanisms*. Routledge.
Bechtel, William (2017). Diagrammatic Reasoning. In Lorenzo Magnani and Tommaso Bertolotti (Eds.), *Handbook of Model-Based Science* (605–618). Springer. https://doi.org/10.1007/978-3-319-30526-4_27
Bokulich, Alisa (2016). Fiction as a Vehicle for Truth: Moving beyond the Ontic Conception. *The Monist, 99*(3), 260–279. https://doi.org/10.1093/monist/onw004

Bokulich, Alisa (2018). Representing and Explaining: The Eikonic Conception of Scientific Explanation. *Philosophy of Science, 85*(5): 793–805. https://doi.org/10.1086/699693

Churchland, Paul (1990). On the Nature of Explanation: A PDP Approach. *Physica D: Nonlinear Phenomena, 42*(2), 281–292. https://doi.org/10.1016/0167-2789(90)90083-2

Coffa, José (1973). *Foundations of Inductive Explanation* (Unpublished doctoral dissertation). University of Pittsburgh.

Collins, Arthur (1966). Explanation and Causality. *Mind, 75*(300), 482–500. https://doi.org/10.1093/mind/LXXV.300.482

Craik, Kenneth (1943). *The Nature of Explanation*. Cambridge University Press.

Craver, Carl (2007). *Explaining the Brain*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199299317.001.0001

Craver, Carl (2014). The Ontic Conception of Explanation. In Marie Kaiser, Oliver Scholz, Daniel Plenge, and Andreas Hüttemann (Eds.), *Explanation in the Special Sciences* (27–52). Springer.

Craver, Carl (2016). The Explanatory Power of Network Models. *Philosophy of Science, 83*(5), 698–709. https://doi.org/10.1086/687856

de Regt, Henk (2015). Scientific Understanding: Truth or Dare? *Synthese, 192*(12), 3781–3797. https://doi.org/10.1007/s11229-014-0538-7

Faye, Jan (1999). Explanation Explained. *Synthese, 120*(1), 61–75. https://doi.org/10.1023/A:1005258504182

Fetzer, James (1991). Critical Notice of *Four Decades of Scientific Explanation*. *Philosophy of Science, 58*(2), 288–306. https://doi.org/10.1086/289617

Forge, John (1986). The Instance Theory of Explanation. *Australasian Journal of Philosophy, 64*(2), 127–142. https://doi.org/10.1080/00048408612342341

Forge, John (1993). How Should We Explain Remote Correlations? *Philosophica, 51*(1), 83–103.

Forge, John (1999). *Explanation, Quantity, and Law*. Ashgate.

Glennan, Stuart (1992). *Mechanisms, Models, and Causation* (Unpublished doctoral dissertation). University of Chicago.

Glennan, Stuart. (2002). Rethinking Mechanistic Explanation. *Philosophy of Science, 69*(3), S342–S353. https://doi.org/10.1086/341857

Glennan, Stuart (2011). Singular and General Causal Relations: A Mechanist Perspective. In Phyllis Illari, Federica Russo, and Jon Williamson (Eds.), *Causality in the Sciences* (789–817). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199574131.003.0037

Glennan, Stuart (2017). *The New Mechanical Philosophy*. Oxford University Press. https://doi.org/10.1093/oso/9780198779711.001.0001

Halina, Marta (2015). Abstraction, Idealization, and the Ontic View of Explanation. Unpublished manuscript.

Hausman, Daniel (2005). Causal Relata: Tokens, Types, or Variables? *Erkenntnis, 63*(1), 33–54. https://doi.org/10.1007/s10670-005-0562-6

Hegarty, Mary (2004). Mechanical Reasoning by Mental Simulation. *Trends in Cognitive Sciences, 8*(6), 280–285. https://doi.org/10.1016/j.tics.2004.04.001

Hempel, Carl (1942). The Function of General Laws in History. *Journal of Philosophy, 39*(2), 35–48. https://doi.org/10.2307/2017635

Hempel, Carl (1965). *Aspects of Scientific Explanation*. The Free Press.

Hempel, Carl and Paul Oppenheim (1948). Studies in the Logic of Explanation. *Philosophy of Science, 15*(2), 135–175. https://doi.org/10.1086/286983

Humphreys, Paul (1989). *The Chances of Explanation*. Princeton University Press.

Illari, Phyllis (2013). Mechanistic Explanation: Integrating the Ontic and Epistemic. *Erkenntnis*, *78*(2), 237–255. https://doi.org/10.1007/s10670-013-9511-y

Illari, Phyllis and Jon Williamson (2011). Mechanisms Are Real and Local. In Phyllis Illari, Federica Russo, and Jon Williamson (Eds.), *Causality in the Sciences* (818–844). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199574131.003.0038

Jenkins, Carrie (2008). Romeo, René, and the Reasons Why: What Explanation Is. *Proceedings of the Aristotelian Society*, *108*(1), 61–84. https://doi.org/10.1111/j.1467-9264.2008.00236.x

Johnson-Laird, Philip (1983). *Mental Models*. Cambridge University Press.

Kaiser, Marie (2014). *An Ontic Account of Explanatory Reduction in Biology* (Unpublished doctoral dissertation). Universität zu Köln.

Kaplan, David M. and Carl Craver (in press). Are More Details Better? On the Norms of Completeness for Mechanistic Explanations. *British Journal for the Philosophy of Science*. Advance online publication. https://doi.org/10.1093/bjps/axy015

Kim, Jaegwon (1994). Explanatory Knowledge and Metaphysical Dependence. *Philosophical Issues*, *5*(1), 51–69. https://doi.org/10.2307/1522873

Kitcher, Philip (1981). Explanatory Unification. *Philosophy of Science*, *48*(4), 507–531. https://doi.org/10.1086/289019

Lycan, William (2005). Explanation and Epistemology. In Paul Moser (Ed.), *Oxford Handbook of Epistemology* (408–433). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195301700.003.0015

Marcus, Russell (2014). How Not to Enhance the Indispensability Argument. *Philosophia Mathematica*, *22*(3), 345–360. https://doi.org/10.1093/philmat/nku004

Mellor, David (1995). *The Facts of Causation*. Routledge. https://doi.org/10.4324/9780203302682

Perini, Laura (2005). Explanation in Two Dimensions: Diagrams and Biological Explanation. *Biology and Philosophy*, *20*(2), 257–269. https://doi.org/10.1007/s10539-005-2562-y

Potochnik, Angela (2017). *Idealizations and the Aims of Science*. Chicago University Press. https://doi.org/10.7208/chicago/9780226507194.001.0001

Ruben, David-Hillel (1990). *Explaining Explanation*. Routledge.

Salmon, Wesley (1975). Theoretical Explanation and Replies to Comments. In Stephan Körner (Ed.), *Explanation* (118–145, 160–184). Yale University Press.

Salmon, Wesley (1977). An 'At-At' Theory of Causal Influence. *Philosophy of Science*, *44*(2), 215–224. https://doi.org/10.1086/288739

Salmon, Wesley (1984). *Scientific Explanation and the Causal Structure of the World*. Princeton University Press.

Salmon, Wesley (1985). Conflicting Conceptions of Scientific Explanation. *Journal of Philosophy*, *82*(11), 651–654. https://doi.org/10.2307/2026421

Salmon, Wesley (1989). *Four Decades of Scientific Explanation*. University of Pittsburgh Press.

Salmon, Wesley (1998). *Causality and Explanation*. Oxford University Press. https://doi.org/10.1093/0195108647.001.0001

Şerban, Maria (2013). Structural Representations and the Explanatory Constraint. *Croatian Journal of Philosophy*, *13*(38), 277–291.

Şerban, Maria (2017). What Can Polysemy Tell Us about Theories of Explanation? *Euro-

pean Journal of Philosophy of Science, 7(1), 41–56. https://doi.org/10.1007/s13194-016-0142-4

Sheredos, Benjamin (2016). Re-Reconciling the Epistemic and Ontic Views of Explanation (or, Why the Ontic View Cannot Support Norms of Generality). *Erkenntnis*, *81*(5), 919–949. https://doi.org/10.1007/s10670-015-9775-5

Strevens, Michael (2008). *Depth: An Account of Scientific Explanation*. Harvard University Press.

Suárez, Mauricio (2010). Scientific Representation. *Philosophy Compass*, *5*(1), 91–101. https://doi.org/10.1111/j.1747-9991.2009.00261.x

Târziu, Gabriel (2018). Importance and Explanatory Relevance: The Case of Mathematical Explanations. *Journal for General Philosophy of Science*, *49*(3), 393–412. https://doi.org/10.1007/s10838-018-9424-1

Thagard, Paul and Karsten Verbeurgt (1998). Coherence as Constraint Satisfaction. *Cognitive Science*, *22*(1), 1–24. https://doi.org/10.1207/s15516709cog2201_1

van Eck, Dingmar (2015). Reconciling Ontic and Epistemic Constraints on Mechanistic Explanation, Epistemically. *Axiomathes*, *25*(1), 5–22.

von Wright, George (1971). *Explanation and Understanding*. Cornell University Press.

Waskan, Jonathan (2006). *Models and Cognition*. MIT Press.

Woody, Andrea (2004). More Telltale Signs: What Attention to Representation Reveals about Scientific Explanation. *Philosophy of Science*, *71*(5), 780–793. https://doi.org/10.1086/421416

Wright, Cory (2012). Mechanistic Explanation without the Ontic Conception. *European Journal of Philosophy of Science*, *2*(3), 375–394. https://doi.org/10.1007/s13194-012-0048-8

Wright, Cory (2015). The Ontic Conception of Scientific Explanation. *Studies in the History and Philosophy of Science*, *54*(1), 20–30. https://doi.org/10.1016/j.shpsa.2015.06.001

Wright, Cory and William Bechtel (2007). Mechanisms and Psychological Explanation. In Paul Thagard (Ed.), *Handbook of Philosophy of Psychology and Cognitive Science* (39–79). Elsevier. https://doi.org/10.1016/B978-044451540-7/50019-0

Yolton, John (1959). Explanation. *British Journal for the Philosophy of Science*, *10*(39), 194–208. https://doi.org/10.1093/bjps/X.39.194