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Scientific Understanding: No Veritism Without Realism, No Realism Without Veritism

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Abstract
Scientific understanding constitutes one of the most firmly settled topics in the philosophy of general science. The most accepted approach within the debate has been the so-called "factivism of understanding." Here, I show analytically how the latter is articulated through the acceptance of two interrelated theses: an epistemological—veritism—and an ontological one—realism. Recently, a group of authors challenged this line of thought by dissociating ontological and epistemological commitments. I examine these proposals, elucidating to what extent they fail in their attempt to formulate a consistent account of scientific understanding. I argue that if one wants to articulate an account committed to a truth-centered epistemology, one should adopt a realist stance; if one wants to formulate a realist account of scientific understanding, one should subscribe to a truth-centered epistemology.

Keywords Representationalism · Truth · Factivism · Knowledge · Models

1 Introduction

Scientific understanding is one of the most firmly settled hot topics in the current corpus of the philosophy of science. The most accepted approach within the debate has been the so-called factivism of understanding. Despite the discrepancies between the different factive accounts, all have assumed in their analyses both epistemological—i.e., veritism—and ontological—i.e., realism—theses. Veritism states that truth constitutes a necessary condition for having adequate understanding. The minimal sense of realism contends that a mind-independent reality provides the truthmakers for *objectively* discriminating genuine scientific understanding. Recently, a group of authors challenged this line of thought by proposing dissociating ontological and epistemological commitments (e.g., Khalifa, 2017; Potochnik, 2017). In other words, they have claimed that it is possible to adopt only one of

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the two theses, leaving aside the other. In this paper, I will show that the veritistic and realistic theses are so closely related that it is unfeasible to dissociate one from the other when formulating a coherent account of scientific understanding. Consequently, if one wants to articulate an account committed to a truth-centered epistemology, one should embrace a realist stance; if one wants to articulate a realist account of scientific understanding, one should adopt a truth-centered epistemology.

The paper will be organized as follows. In the first section, I will analytically reconstruct the state of the art on scientific understanding. I will focus on the factive proposals since they have been widely accepted and discussed. I will illustrate how the latter have been articulated on the acceptance of the two possible senses of factivism, the ontological—i.e., realism—and the epistemological—i.e., veritism. In the second section, I will illustrate this tight association through concrete proposals. In the third section, I will analyze the attempts to separate realism from veritism and vice versa. First, I will delve into Angela Potochnik's proposal, which has tried to eschew veritism while preserving realism. I will present two arguments to evidence the problems in distancing herself from veritism. Second, I will analyze Kareem Khalifa's proposal, which has tried to retain veritism at the expense of realism. Similarly, I will formulate two arguments to illustrate the difficulties of leaving realism behind.

2 The Standard (Quasi)Factive Account: Veritism plus Realism

Several authors have offered strong arguments to consider understanding, not truth or knowledge, as the goal of scientific practice (Potochnik, 2017, pp. 19–20; see also Kvanvig, 2003, 2009). Although there is a plurality of different proposals, it is possible to identify two major approaches: factivism and non-factivism. Since the former has received more attention, I consider it necessary to shed light on its theoretical foundations and tenability. Factivism is a technical term often introduced in two undifferentiated and unrecognized ways: epistemological and ontological. Let me delve into these two senses and elucidate their close relationship.

The epistemological sense arises due to the connections existing between understanding and truth/knowledge. The factivist holds that to understand "p," it is necessary to know that "p," which requires that "p is true." One simply cannot understand something if one does not know that something. Note that it does not suffice for the beliefs or propositions that structure understanding to be justified: they must be true. Therefore, to understand factively, the agent must grasp some kind of true information about the phenomenon (Audi, 2011, p. 22; Williamson, 2000, p. 21). What is at issue here is the so-called traditional or classical conception of knowledge which includes three conditions (BonJour, 2010, p. 24): the belief, the truth, and the justification condition. The second one is of interest. It states that, to constitute knowledge, there must be a certain adequacy between the content of the propositional element and the parcel of the world to which it refers (BonJour, 2010, p. 30). This condition confers factivity to knowledge and, hence, to understanding. In epistemology, veritism constitutes the theoretical approach that places truth at the center of the analysis. The latter is viewed as the necessary condition that regulates the elicitation

of epistemically adequate products capable of producing scientific understanding. As can be guessed, veritism has been the main epistemological approach adopted when conceptualizing the nature of scientific understanding (Greco, 2014; Grimm, 2006, 2008; Kelp, 2015, 2018, 2021; Khalifa, 2017; Kuorikoski & Lehtinen, 2009; Kuorikoski & Ylikoski, 2015; Kvanvig, 2003, 2009; Strevens, 2008, 2013; Ylikoski & Kuorikoski, 2010).

The close association between understanding and truth/knowledge has been interpreted differently. Some authors have argued that understanding is nothing but a kind of knowledge (Grimm, 2006). Other authors have contended that, even when factive understanding is tied to truth/knowledge, it should not be equated with them. Knowledge/truth is a necessary condition for acquiring understanding, but it is not a sufficient condition. If so, then understanding would be just another term for knowledge. Jonathan Kvanvig (2003), Khalifa (2017) or Christoph Kelp (2021, pp. 105–107) have argued that one aspect that distinguishes understanding from knowledge is that the former requires systematically relating beliefs or bits of information. Understanding, unlike knowledge, requires the agent to take an active position in establishing systematic relations between the latter. Regardless of whether one adopts a more or less restrictive position on the association between knowledge and understanding, all these authors agree in stressing that there are close connections between the two terms. To have factive understanding, the agent must grasp some kind of *true*, and not only justified, *information* about the phenomenon under study (Audi, 2011, p. 22).

It has been argued that these bits of information must be related in a specific way: through explanatory narratives (e.g., Khalifa, 2017; Strevens, 2013). The cognitive agent must be able to formulate explanatory accounts that answer certain why-questions. Although there are various types of explanations (mathematical, topological, equilibrium, or probabilistic, among others), the ones that have traditionally dominated philosophical reflection on understanding have been causal and mechanistic explanations. Thus, a cognitive agent understands a certain aspect of the phenomenon under study when he or she can grasp or provide sound—true—explanatory answers to valid—contextually relevant—scientific questions. Admittedly, a considerable bulk of authors have advocated a view that grants conceptual independence between understanding and explanation (see, e.g., Dellsén, 2020; Kelp, 2021; Lipton, 2013).[1] Be that as it may, some of them have even conceded that high-grade understanding necessarily requires an explanation (e.g., Kelp, 2015, p. 3815). Consider the following example. In recent years, it has been suggested that cancer cells may invade tissues through an alternative process to the traditional enzyme-based one (Glentis et al., 2017). A specific type of stromal cell, i.e., cancer-associated fibroblasts, would exert mechanical forces on the basement membrane. This will result in the alteration of its physical properties, thus leading to the formation or enlargement of existing spaces. In turn, this would decrease its rigidity and integrity, thus facilitating the invasion of cancer cells. The explanation and understanding of this alternative invasion

[1] Some of these authors have supported the approach known as "the objectual view of understanding" (Dellsén, 2020; Lipton, 2013). However, it has not been the prevailing view.

process will be true iff, indeed, the aforementioned causal mechanism is effectively confirmed.

The epistemological sense of factivism has not been problem-free. It has been consistently shown that scientists use modeling tools such as abstraction—i.e., deliberate omission of certain aspects of the target system—and idealization—i.e., deliberate distortion of certain features of the target system. But not only that, its value and inevitability have been similarly evidenced: they facilitate access to certain information about the target system by eliminating potentially misleading factors and highlighting those that do the real epistemic work (Morrison, 2015). For this reason, factivists have been forced to nuance their position, advocating what is currently known as quasi-factivism (Kvanvig, 2003, 2009). To advocate the factive character of understanding, not all the propositions that structure explanations need to be true. Only those that refer to the elements of the world involved in the emergence of the phenomenon—i.e., difference-makers. This reformulation allows us to make sense of the introduction of falsehoods. They would affect propositional elements that have a peripheral and accidental role in the emergence of the phenomenon or behavior under consideration (see, e.g., Greco, 2014, pp. 296–297; Kvanvig, 2009, p. 343). An enlightening example is found in cancer research. Although the important role of the microenvironment in the acquisition of the so-called cancer hallmarks is now recognized, there is disagreement as to what role to assign to it. Some researchers, more interested in analyzing the genetic networks involved in cell cycle regulation, have ascribed to them a mere enabling role (Hanahan & Weinberg, 2011, p. 661). For them, to understand cancer-defining features, it is critical to analyze genetic factors, leaving aside the environmental ones, such as stromal cells or physical forces.

Having addressed the epistemological sense, it is possible to deepen the ontological one. The latter is expressed through the links that exist between understanding and the world. The latter guarantees the truth value of the propositions on which the former is structured. A truthmaker in the world makes the proposition true: "Factive mental states are important to us as states whose essence includes a matching between mind and world" (Williamson, 2000, p. 40). It should be noted that the existence of an objective reality with an already given structure independent of any pragmatic consideration makes the idea of factivity effective. Otherwise, the veritist epistemological counterpart would lose all its content: we would have no objective criterion, i.e., truth, to distinguish genuine factive understanding. It would become a mere pragmatic question dependent on the idiosyncrasy of the research community: "If there is no objective reality–no way the world is, regardless of perspective–then truth also will be relative to perspective" (Godfrey-Smith, 2021, p. 301).

Advocates of factivism do not defend a naïve, realistic view where understanding is *de re* (Salmon, 1984). There is now a consensus that explanations have a representational format. By making use of the available background knowledge, cognitive agents construct, structure, detail, or present explanations through a variety of representational devices. This involves a semantic ascent in which the ontic is no longer conceptualized as something that can be directly grasped. It is now captured indirectly through *veridical representations*. Models provide understanding iff the descriptions of phenomena—i.e., their explanations—represent the causally

relevant properties that account for the emergence of the behavior of interest of the target system. So pervasive and widely assumed is the idea that models provide factive understanding insofar as they *veridically represent certain aspects* of the ontic structure of phenomena that it has been defined as "the Standard View" (Morrison, 2015, p. 97; Potochnik, 2017, p. 43; Frigg & Nguyen, 2017, p. 49; Rice, 2021). Regt and Gijsbers (2016) have contended: "*The veridicality condition* is (…) the thesis that *science provides understanding of the world only if its theories are at least approximately true descriptions of reality,* in its observable as well as unobservable aspects" (de Regt & Gijsbers, 2016, p. 3, my emphasis). Here, we can appreciate the other side of the interrelation between the two senses of factivism. In this case, the dependence of the ontological sense on the epistemological one: it is the truth that provides us with the necessary criteria to determine whether the propositions that structure understanding are adequate or not.

Admittedly, a great bulk of factive authors have recently proposed a refined view of the veridicality thesis motivated by the upsurging of the so-called *holistically distorted models* (e.g., Bokulich, 2016, 2018; Grimm, 2006; Rice, 2021). Holistically distorted models refer to those models in which even the elements considered epistemically central are idealized—the difference-makers. It is precisely the distortions introduced that allow the application of mathematical analysis tools to obtain information about the target system under consideration that would otherwise be impossible (Rice, 2021). Consider the following example.[2] Peng and colleagues (2017) have devised a continuum model that yielded information on how the mechanical and biophysical properties of the microenvironment may affect the key functions that guide the cell fate transition occurring in mesenchymal stem cells (MSCs). Here, cell–cell and cell-niche interactions, which are known to be crucial in stem cell differentiation, are not included within the model. Furthermore, only four lineage-specific genes are considered, even though a larger number of genes are known to be involved in the regulation of MSC fate. Nevertheless, the model provides valuable clues to guide experimental strategies/research programs and to develop new regenerative therapies.

Note that holistically distorted models bear no direct representational relation to their respective target systems: it is unfeasible to decompose the model by differentiating the contributions of the precise parts from the idealized ones, connecting the former with characteristics, causal patterns, or mechanisms in the world. Notwithstanding, "sophisticated factive authors" have argued that these models can still represent certain aspects of the corresponding target system, providing factive understanding. To preserve the epistemic character of these kinds of models and their contribution to understanding, they have differentiated between "literalism" and "representationalism." Access to the ontic structure of phenomena would not occur directly by veridically representing certain causes or mechanisms but indirectly by evidencing the counterfactual (in)dependence relationships between certain variables of the system. If systems with different material instantiations allow us to identify the same invariant patterns of behavior, then the models give an idea of what the ontic structure of the phenomenon is, being, therefore, representational.

[2] Other instructive examples can be found in climate science.

Finally, one point deserves to be clarified: understanding has not been usually conceptualized as an all-or-nothing issue. Several authors, such as Khalifa or Kelp, have argued that it is possible to understand even when we do not have an explanation per se. One has a certain kind of understanding—i.e., proto-understanding—when one grasps some explanatory roles, thus being on the right track to achieve full explanatory understanding (Khalifa, 2017, pp. 86–87).

In sum, the veritistic and realist theses seem to be indissociable from a factive conceptualization of understanding: it is the world that guarantees the truth value of propositions; it is the truth that provides us with the necessary criteria to determine whether the propositions that structure understanding stand for reality. Factivity requires that both theses are understood jointly. Note that I do not claim that realism sensu lato requires an epistemological thesis: there are realist positions that are committed only to ontological theses. Neither do I claim that a truth-centered epistemology sensu lato requires realist ontological theses. My contention is that both theses seem to be necessary if one wants to articulate an account of understanding committed either to the ontic or epistemic sense.

3 Some Examples

In this section, I will illustrate the tight connection existing between the two senses of factivism—i.e., veritism and realism—by introducing some examples of the different variants of factive approaches: the classical, the sophisticated, and the objectualist.

Let's proceed with the classical version of factivism, which holds that understanding is obtained by articulating explanatory accounts that *veridically or literally represent* some difference-maker. Take the influential account of understanding proposed by Strevens as an example. According to him, an agent understands a phenomenon when she grasps—and not only when she knows—which aspects of the structure of reality account for the emergence of the characteristics or behaviors of interest. That is, a causal explanation that targets specific elements of the world (Strevens, 2008, p. 3; see also Strevens, 2013, p. 1). Scientific understanding requires being able to articulate true answers to relevant "why" questions (Strevens, 2013, p. 510). What is critical is that the explanation must be internally correct. This demands that the *explanans* of the explanations *be true*, which requires that the difference-makers in the model systems reliably represent the respective elements of the *causal structure of the world* (Strevens, 2013, p. 512). Certainly, not all the components that structure such explanations need to be true (Strevens, 2008, 2013). Canonical models—do not contain falsehoods—are not the only epistemically valuable ones. Those that rely on idealizations can also provide full-fledged understanding. To gain understanding through their use, it is necessary to: 1. Identify and accurately represent in our explanations what we call "difference-makers" (Strevens, 2008). 2. Understand why these factors or processes are causally central.

Let's move to the sophisticated factive versions. As previously shown, the veridicality condition takes on a nuanced guise: representation is decoupled from

literalism. This move was effectuated to accommodate the existence of holistically distorted and fictitious models. Here, I will restrict my analysis by simply outlining the account developed by Kuorikoski and colleagues. For Ylikoski and Kuorikoski (2010), an agent understands a phenomenon when she is able to answer contrastive questions ("what-if-questions"). This requires the agent to be able to relate possible values of the *explanans* variable to possible values of the *explanandum* variable (Ylikoski & Kuorikoski, 2010, p. 205).

Their account overtly supports veritism. For these authors, it is not enough for agents to make counterfactual inferences; these must be true: "it is the truthlikeness of the substantial assumptions that ultimately carries the epistemic weight in a model" (Kuorikoski & Lehtinen, 2009, p. 127). Only if such inferences are true is it possible to conclude that the model is genuinely representative and that agents have a factive understanding. Kuorikoski and Ylikoski argue that, to be true, these explanations must coincide with the *ontological modal dependency relations* to a sufficient degree (Kuorikoski & Ylikoski, 2015, p. 3828). It is the interrelationship between realism and veritism that holds the objective character of this account (Kuorikoski & Ylikoski, 2015). Otherwise, we would be subscribing to a sort of non-factive understanding engaged with pragmatic criteria of evaluation (e.g., Kuorikoski & Ylikoski, 2015, p. 3827; Ylikoski & Kuorikoski, 2010).

The association of veritist and realist assumptions can also be appreciated in objectualist accounts. Consider the one developed by Christoph Kelp (2015, 2021). He has argued that worldly phenomena have an internal ontic structure. The latter sets the conditions of possibility for scientists to articulate an adequate set of true propositions to describe their corresponding properties and relations. An agent understands when he grasps them: "Second, *phenomena come with structure* […]. After all, for every phenomenon, no matter what its metaphysical nature might be, *there is a set of true propositions that describes it"* (Kelp, 2021, p. 101, my emphasis; see also, Kelp, 2015, p. 3809). Thus, realism stems from a commitment to the existence of a structured reality. Veritism follows from its commitment to a knowledge-based understanding (Kelp, 2015, p. 3815; see also Kelp, 2017).

For Kelp, having a complete description of the phenomenon is not enough. Such knowledge must be as connected as possible. On the basis of these considerations, Kelp proposes a maximal notion of understanding: "Maximal Understanding. One has maximal understanding of a phenomenon, P, if and only if one has maximally systematic knowledge of P" (Kelp, 2021, p. 107). Since our cognitive capacity is limited and finite, Kelp recognizes that no one is in a position to achieve such maximal understanding. However, it constitutes the ideal to aspire to. Therefore, the adequacy of our understanding will be assessed according to how close it is to this maximum understanding. From these considerations, Kelp derives the notion of degrees of understanding (Kelp, 2021, p. 108). As a final step, Kelp combines these considerations with contextualist semantics. Nothing makes it impossible to support realism and factivism while stressing the importance of pragmatic needs. For Kelp, an agent understands a phenomenon to the extent that she exceeds a certain threshold set by the context (Kelp, 2021, p. 108). This threshold is reached by successfully carrying out a particular task through certain skills (Kelp, 2021, p. 111). However, as an objectualist, Kelp separates himself from explanatory conceptions of

understanding. He argues that it is possible to get close to complete and maximally well-connected knowledge of a phenomenon without having an explanation.

4 Dissociating Realism and Veritism

Recently, it has been argued that realism and veritism need not necessarily go hand in hand when articulating an account that preserves the objective character of scientific understanding. Part of the reasons adduced for promoting this dissociation lies in the conceptual riddles that have arisen with the spread and increasing prominence of non-representational models, such as holistically distorted ones. For example, how is it possible for a model system to grant understanding about certain aspects of a target system without faithfully representing them; how is it possible for misrepresentation to play a role in the construction of understanding.

As previously seen, some authors have argued that it is possible to address these questions while keeping the association between realism and veritism untouched (i.e., the sophisticated factive versions). Here, both commitments are retained by appealing to the idea of stable patterns of behavior articulated through modal reasoning as a form of non-literal representation. Arguably, there may be simpler ways of preserving the "objective component" of scientific understanding: Just leave aside the sense of factivism that causes the problems! Two sharply differentiated positions have emerged: some have suggested leaving aside the veritistic sense and others the realistic one.

Concerning the first position, it has been contended that "objectivity" lies on the ontological side. A paradigmatic example is Angela Potochnik, who has offered a proposal that sets aside veritism while embracing a sophisticated form of realism. In *Idealization and the Aims of Science*, she articulated a non-factive but yet a realist account of scientific understanding (Potochnik, 2023a, p. 155). She stated: "Understanding is, accordingly, not factive" (Potochnik, 2017, p. 113); and also: "But by the reality of causal patterns, I simply mean that there are objective regularities in manipulability relations" (Potochnik, 2017, p. 208).

Concerning the second position, it has been argued that the "objective" component lies on the epistemic side. The goal should consist in articulating a truth-centered proposal that adopts a non-inflated ontological stance. A paradigmatic case within the literature is Kareem Khalifa, who has formulated a factive account agnostic about the realism vs. non-realism debate. He contended: "I defend 'inquisitive' veritism, wherein the only epistemic goal of science are true answers to relevant questions" (Khalifa, 2020, p. 946); and also: "I'm not taking a stance on the realism issue" (Khalifa, 2017, p. 25). Khalifa embraces what he calls "explanatory voluntarism," which subscribes to a liberal stance on ontological requirements (Khalifa, 2017, p. 157).

Regardless of whether one calls oneself a factivist (i.e., Khalifa) or a non-factivist (i.e., Potochink), there is a connecting thread linking these proposals. Both share the minimal intuition that traditionally characterizes the proposals commonly qualified as "factivist": to ensure objective criteria for assessing the adequacy of understanding that include the importance of social and contextual aspects but do not rely on them.

This intuition is still present even when factivism is expressly denied, as Potochnik does: "genuine understanding requires not only the proper cognitive state but also the proper relationship between that cognitive state and the world" (Potochnik, 2017, p. 113; see also, 2017, p. 208). Consequently, one may argue that the difference between the two positions lies in which sense is privileged when defending the objective character: the ontic or the epistemic. In what follows, I will analyze both proposals, illustrating their main shortcomings in separating both senses.

4.1 Realism Without Veritism: Angela Potochnik's Account

Potochnik has stated that veritistic proposals are threatened by the widespread use of distortions, abstractions, and idealizations. More specifically, she has structured her critique as follows (2023a, pp. 154–155):

1. An "Y" explanation can account for a given phenomenon without the necessity of being completely true.
2. An idealized "Y" explanation can better account for a given phenomenon than a more precise "Z" explanation.
3. Idealized elements in explanation "Y" may be crucial in accounting for the phenomenon, even though they are radically false.

She concludes that it is reasonable to state that understanding must be non-factive (Potochnik, 2017, p. 113). Nevertheless, Potochnik considers herself a realist. More specifically, she defends a nuanced realism that does not imply the acceptance of an epistemological—truth-centered—and semantic—correspondence-centered—thesis (for versions where these are included, see, e.g., Psillos, 1999). The heart of Potochnik's realism lies in the idea of *causal patterns.* The latter are defined as regularities responsible for the occurrence of the phenomenon (Potochnik, 2017, p. 29; see also 2017, p. 135). They are grasped by detecting the degree of specificity between two variables: intervention on the values of one variable leads to specific changes in the values of another variable. Note that these patterns involve generalizations across multiple instantiations (Potochnik, 2017, p. 32). Thus, a causal pattern is revealed when, over a given range of systems that have different values for specific variables or different material components (e.g., models that explore the evolutionary dynamics of different taxa), more or less invariant results are obtained (Potochnik, 2017, p. 136).

Based on these considerations, Potochnik argues that pluralism constitutes the most suitable philosophical position to articulate efficient research. She distinguishes between "objects of knowledge" and "targets of the investigation" to prove this point. The object of knowledge constitutes the patterns of counterfactual dependence (Potochnik, 2023a, pp. 157–158). The target of investigation is the phenomenon itself (e.g., the dynamics of a population or a certain carcinogenic process), which embodies a multiplicity of causal patterns that may correspond to different characteristics (Potochnik, 2017, p. 28). Researchers decide which pattern will be analyzed based on their interests and competencies. This means that knowledge about the target of the investigation would always be incomplete. Agents

will usually falsify those patterns that are not of interest to them. This is why it is necessary to adopt pluralism. To substantiate the argument, Potochnik invokes the concepts of "causal relevance" and "explanatory relevance": a given element may be causally relevant but not explanatorily relevant to the goals that drive a given research project. Even though explanations are strictly false, because they do not represent the phenomenon itself, they still represent *certain causal patterns* therein and thus provide understanding (Potochnik, 2023a, p. 164).

Note that introducing pragmatic-contextual aspects and accepting pluralism do not undermine the idea of objectivity. Causal patterns remain objective facts of the world that make true our cognitive states. In other words, they are self-standing elements of the world upon which the idea of objectivity is grounded. This means that Potochnik still commits to the minimal thesis of realism. Namely, a mind-independent reality: "causal patterns are 'genuine [features] of the world'. Their existence is not qualified or conditioned by the context that enabled its discovery" (Potochnik, 2023b, p. 176). The distinctive point of Potochnik's realism is that it is not necessary for propositions *to accurately reflect* those states of the world. Here is where her qualified realism departs from veritism: It is possible to represent the structure of the world, although not literally. Note that it is not the existence of a mind-independent structure that is qualified but how the latter is grasped. In fact, this ontological stance bears remarkable similarities to sophisticated factive versions: both appeal to stable patterns of behavior based on counterfactual reasoning. This should not be surprising. It only supports the main thesis advocated in this paper: the tight link existing between realism and veritism when articulating a coherent vision of scientific understanding.

However, Potochnik is reluctant to accept the veritistic counterpart of the factive versions. In order to avoid the "truth talk," she adheres to the same line of reasoning advanced by advocates of the Ontic Conception, such as Craver (2014), Strevens (2008), or Salmon (1984): "conceived ontically, however, the term explanation refers to an objective portion of the causal structure of the world (…). Ontic explanations are not texts; they are full-bodied things" (Craver, 2014, p. 40). Causal patterns, rather than being incarnated in representations, texts, or arguments, would constitute objective entities that subsist *de re* regardless of whether anyone perceives them: "I intend causal patterns to be regularities in phenomena themselves" (Potochnik, 2017, p. 26). Accordingly, models would constitute epistemic tools that facilitate grasping these causal patterns subsisting *de re* (Craver and Kaplan, 2020, p. 16). In what follows, I will present two arguments that prove how her strategy for disassociating herself from veritism fails.

4.1.1 The Representational Turn Argument

The first argument is intended to show that Potochnik is eventually forced to accept a representational turn in the conceptualization of causal patterns. This leads to two possible scenarios: either to recognize that her position is inadequate since it is necessary to appeal to truth talk, or to recognize that her position is incomplete since it is necessary to articulate an alternative criterion to discriminate between correct and misguided representations.

Currently, the ontic conception of explanation as initially formulated enjoys little acceptance (Bokulich, 2016, p. 263). It is hard to accept that explanations or causal patterns constitute objective elements directly grasped and not the product of a sort of epistemic achievement. The literature on scientific modeling and representation has shown how it is by constructing and manipulating purposefully designed devices that cognitive agents can devise certain types of robust representations to satisfy the intended research goals. Thus, it seems problematic to state that causal patterns constitute "things of the world" that stand independently of any epistemic work carried out by cognitive agents. Even strong advocates of this view, such as Craver and Kaplan (2020), have recognized the representational and agential character of explanations/causal patterns.

In several instances, Potochnik admits the inevitability of the representational turn already stated: "On this view, patterns are not themselves human representations but are depicted by our representations" (Potochnik, 2017, p. 26). More importantly, once we recognize that models and representations are necessary and the product of human agency, we need a criterion to discriminate between those that are correct and those that are misguided. Even Craver has noted this point: "the theory should illuminate the criteria that distinguish good explanations from bad" (Craver, 2014, p. 28). The following paragraph summarizes how Potochnik leans towards the same considerations: "*Successful scientific explanations proceed* via *representation and connect properly to the world in virtue of their representational success*" (Potochnik, 2017, p. 133, my emphasis).

Therefore, she acknowledges that scientific understanding stems from the *faithful/veridical representation* of causal patterns. At this point, the way is paved for the introduction of truth talk. The latter would represent the criterion that makes it possible to discriminate between explanations that genuinely target causal patterns and those that do not. If we remain reluctant to accept truth, as Potochnik seems to be, what alternative criteria would allow us to distinguish good models/representations from bad ones? How can we know whether models adequately represent aspects of reality? Potochnik leaves these questions unanswered.

In sum, the argument presented can be summarized as follows. Either her proposal is incomplete since she has yet to provide conceptual tools unrelated to truth to justify how it is possible to discriminate whether representations are adequately connected to reality. Or it is inadequate, given that she is eventually bound to embrace veritism. Otherwise, her realist stance would be in serious trouble.

4.1.2 The Inconsistent Analysis Argument

The second argument is aimed at proving that Potochnik's analysis is internally inconsistent. Despite rejecting veritism, she makes continuous appeals to the idea of truth to support the realist component of her proposal. This again leads to two scenarios: either to recognize that her account is inadequate since the defense of realism is based on the implicit acceptance of veritism, or accept that the approach is incomplete since she must still show how to support realism without relying on veritism.

Potochnik argues that her account is non-veritist and that, consequently, her notion of understanding is non-factive. However, the idea of knowledge is omnipresent in her writings:

> First, the pattern must be embodied by the target phenomenon. This entails that the *causal claim(s) are approximately true*—importantly, they need not be a comprehensive account of the phenomenon but merely depict the influence of at least one causal factor. Even the same causal factor(s) may be depicted differently in characterizations of distinct causal patterns, but *the claims themselves still must be approximately true* (tout court, not merely within a specific research context). (Potochnik, 2023a, pp. 159–160, my emphasis)

She explicitly connects the ideas of "understanding" and "knowledge-truth," something typical of factive proposals. To her mind, the realistic dimension concerns the production of knowledge: "We come to understand phenomena by *generating knowledge* of causal patterns they embody" (Potochnik, 2023a, p. 161; see also, 2023b, p. 173). The idea of truth is consubstantial to knowledge. This was explained due to the factive character of knowledge: it is not possible to know that "p" if "p is not true." Admittedly, there are alternative conceptualizations of knowledge (e.g., Williamson, 2000), but Potochnik seems to stick to the classical view. She clearly states that knowledge consists in the true description of causal patterns: "the depiction of the causal pattern, including any idealizations, would entail is specified by the (approximately true) explanandum as having occurred" (Potochnik, 2023a, p. 160). An agent would understand when the explanations on which it is based truly represent the corresponding causal patterns in the world:

> *Scientific explanations must be connected in the proper way to features of the world*; this is what allows them to convey information about that world and information of the right kind to be explanatory. Put most broadly, *an explanation must reflect what is (in some sense) responsible for the event to be explained.* (Potochnik, 2017, pp. 125, my emphasis)

Several paragraphs show how extensively Potochnik draws on truth-related epistemological considerations to support her realist stance: "And so, posits central to representing a focal causal pattern in some phenomenon must *accurately represent the causal factors contributing to this pattern*. This ensures the phenomenon embodies the focal causal pattern" (Potochnik, 2017, p. 157, my emphasis). In addition, Potochnik explicitly states that models that include idealizations cannot deviate significantly: "*Idealizations, in contrast, must simply not go too far wrong*. To qualify as epistemically acceptable, they simply must help the representation approximate the behavior of the phenomenon in relevant respects" (Potochnik, 2017, p. 157, my emphasis; see also 2017, p. 100). It is not intuitively clear how to determine when idealizations have gone too far in misrepresenting the phenomenon without appealing to veritism. If veritism is rejected, it is germane to elucidate the criteria that allow us to determine when knowledge

derived from such patterns is, in fact, adequate; when the explanations indeed reflect the causal patterns embodied in the phenomena.

In sum, there are compelling reasons to conclude that Potochnik surreptitiously acknowledges in her writings that veritism is necessary to articulate a normative criterion to support the realistic character of her proposal. This is paradoxical given her rejection of factivism. In order to formulate a consistent proposal, she has yet to articulate a non-classical notion of knowledge/truth or invoke alternative criteria of correctness that would allow the realist component to be retained.

4.2 Veritism Without Realism: Kareem Khalifa's Account

Khalifa has articulated a quasi-factive model of understanding, called EKS (Explanation-Knowledge-Science), which is based on the following principle: "Explanatory Floor: Understanding why P requires possession of a correct explanation of why P" (Khalifa, 2023, p. 33). As can be appreciated, veritism is overtly embraced: "I defend 'inquisitive' veritism, wherein the only epistemic goal of science are true answers to relevant questions" (Khalifa, 2020, p. 946; see also Khalifa, 2017, p. 155).

Khalifa takes as a starting point an ideal notion of understanding: "Ideal Understanding: S ideally understands why p if and only if it is impossible for anyone to understand why p better than S" (Khalifa, 2017, p. 4; see also 2017, p. 15). He argues that this ideal understanding is difficult to achieve. However, it provides the basis for outlining a contextual, gradual approach to understanding: "Outright Understanding: 'S understands why p' is true in context C if and only if S has minimal understanding and S approximates ideal understanding of why p closely enough in C" (Khalifa, 2017, p. 5).

Based on these considerations, he argues that the EKS model consists of two principles, EKS1 and EKS2:

> (EKS1) S1 understands why p better than S2 if and only if:
> (A) Ceteris paribus, S1 grasps p's explanatory nexus more completely than S2; or
> (B) Ceteris paribus, S1's grasp of p's explanatory nexus bears greater resemblance to scientific knowledge than S2's. (Khalifa, 2017, p. 14)
> (EKS2) S has minimal understanding of why p if and only if, for some q, S believes that q explains why p, and q explains why p is approximately true. (Khalifa, 2017, p. 14)

EKS1 includes (A) the Nexus Principle and (B) the Scientific Knowledge Principle. The explanatory nexus of EKS1 refers to the set of correct explanations and the relations between them captured by the agent. Consequently, an agent S1 will have a better understanding than S2 as long as she has a greater number of true explanations of the phenomenon and knowledge of the relationships between them. The Scientific Knowledge Principle of EKS1 states that an agent S1 will have a better understanding of a phenomenon than S2 if the explanations and their interrelationships more closely resemble scientific knowledge (Khalifa, 2017, p. 25). For Khalifa (2023, p. 35), scientific knowledge of an explanation is achieved when one's commitment to an explanation could not easily have been false given the ways in which

that explanation was compared (SEEing). Scientific Explanatory Evaluation (SEEing) delineates the conditions that must be met to get an increasingly better understanding: we have to consider a greater number of explanations, compare them, and develop doxastic attitudes based on these comparisons (Khalifa, 2023, p. 35). How those explanations will be compared will depend on the best methods and evidence available at the time (Khalifa, 2017, p. 22). In this sense, Khalifa concedes that context has a crucial role in evaluating whether an explanation, and thus understanding, is adequate and correct. The importance of context is illustrated in the notion of empirical fitness:

> An explanation Q of P is empirically fit in context C if and only if for all other explanations Q* that also deserve consideration as an explanation of P in C, the judgment that Q* better explains why P than Q is unsafe given the best evidence and best methods available in C. (Khalifa, 2023, p. 41)

EKS2 states that it is possible to get understanding even when it is not ideal. That is, it is possible to understand even when we do not have an explanation per se. Khalifa considers it possible to have proto-understanding. An agent has a proto-understanding when he/she grasps the explanatory roles, thus being *on the right track* to achieve full explanatory understanding (Khalifa, 2017, pp. 86–87). This proto-understanding will improve as it approaches the cognitive benefits delineated by EKS1.

The striking point is that Khalifa rejects the realist sense of factivism by stating that his proposal is not committed to any ontological position: "I'm not taking a stance on the realism issue" (Khalifa, 2017, p. 25). Elsewhere, he contends: "adding truth-talk to the Explanatory Floor does not mean that I have strengthened the Explanatory Floor's truth-requirements" (Khalifa, 2023, p. 44; 2017, p. 157). This conceptual move seems to be intended to grant three points: (1) to formulate a general theory of understanding that both realists and anti-realists can accept; (2) to avoid the classic problems raised against realism (e.g., pessimistic meta-induction, inconsistent models, or holistic distortions); and (3) to avoid the complexities associated with this debate (e.g., Khalifa, 2017, p. 7). In what follows, I will present two arguments that demonstrate how his strategy to disassociate himself from realism fails.

4.2.1 The Meaning of Truth Argument

This argument is intended to show that explanatory voluntarism is not solidly supported due to the conceptual ambiguities regarding the idea of truth handled. This results in the following scenario. Either Khalifa's proposal is flawed since he relies on the traditional realist concept of truth, thus embracing a minimal sense of realism, or it is incomplete since he should clarify what meaning of truth is being employed. If the latter, then it is still not clear that veritism can be satisfactorily separated from realism.

As previously seen, truth plays a crucial role in Khalifa's proposal. SEEing and empirical fitness are grounded in Khalifa's theory of explanation, which places truth at the center of analysis:

> q (correctly) explains why p if and only if:
> (1) p is (approximately) true;
> (2) q makes a difference to p;
> (3) q satisfies your ontological requirements (so long as they are reasonable); and
> (4) q satisfies the appropriate local constraints. (Khalifa, 2017, p. 7)

Certainly, the concept of truth has been quite elusive. Even when it may take many different guises, it has been the realist interpretation that has enjoyed preeminence (e.g., BonJour, 1985, p. 4). To preserve explanatory voluntarism, thus avoiding any realist commitment, Khalifa should distance from the latter. To do so, he can resort to two different strategies. First, he may draw on a deflationary view of truth, thus avoiding the challenge of defining what the nature of truth is. However, Khalifa does not seem to attribute to truth the role of a mere expressive grammatical device; it is the element involved in ascertaining whether or not we are approaching the ideal understanding. This suggests that truth has certain properties that deserve to be defined, compelling us to consider the substantialist theories. Second, accepting the substantialist approach, he could lean towards a theory devoid of ontological commitments, such as the coherence theory of truth. Since truth is defined through the adequate relation between linguistic elements, no commitment of an ontological nature is necessary: the nature of reality plays no role. However, this does not seem to be a feasible option either. Coherentism would empty the idea of objectivity related to veritism of its content. The criticism classically raised against this theory is precisely its connection with relativism: we would not have an objective criterion to differentiate, not only intracommunitarily but also intercommunitarily, which explanations indeed provide a factive understanding (see, e.g., Elgin, 1996).

Khalifa seems to need to appeal to a relational and asymmetrical notion of truth: truth is a property that *propositional elements* acquire when they enter into a proper relationship with *non-propositional elements*. Meaning provides the conditions the proposition must meet to be true—truth-criteria. If these conditions are fulfilled, then it is possible to claim the proposition is true (Burgess & Burgess, 2014). This demands that an adequate relation exists between the meaning of a proposition and the corresponding state of the world to which it refers. Truth results to be an eminently *semantic* and not an epistemic issue. This is what allows Khalifa to make sense of the factive character of understanding, thus maintaining the objective component stressed by veritism in associating understanding with knowledge: the correctness of the former transcends communitarian idiosyncrasies (Engel, 2002, p. 15).

The heart of the matter is that Khalifa must address what we mean by non-linguistic reality and how it relates to linguistic elements. Admittedly, one can endorse an idealistic way of conceiving what reality is. However, this does not seem to be the case. Otherwise, there would be no way to justify objectively whether the explanation is true, thus violating the intuitive idea underlying Khalifa's veritism. In fact, even if one recognizes the importance of contextuality in the evaluation of explanations (recall the idea of empirically fit), the truth of the difference-makers included

in explanations is not something that ultimately depends on the researchers, but on the world. In other words, on how the chosen difference-makers included in the explanations fit the world given the available evidence and methods. But not only that, the idea of ideal understanding seems to lead to the acceptance of the existence of a mind-independent reality. Note that the idea of degrees of understanding, despite being contextual, necessarily depends on the former, which is non-contextual. Here, it is assumed an ideal understanding determined by the nature of the facts that remain independent of the researchers. In the end, this makes sense because truth is an absolute notion: "That truth is absolute—there is, strictly, no such thing as a proposition's being more or less true; propositions are completely true if true at all. (Absoluteness)" (Wright, 1998, p. 60). These considerations seem to point to the need to adhere to some minimal form of realism.

In sum, either his proposal contains internal tensions since maintaining veritism requires embracing a realist notion of truth or it is incomplete. Therefore, Khalifa must either recognize the union between veritism and realism or propose an alternative way of conceptualizing the nature of truth.

4.2.2 The Inconsistent Analysis Argument

The second argument purports to illustrate that the defense of explanatory voluntarism is inconsistent. In the end, either veritism is weakened or some ontological stance is adopted.

In line with his veritistic commitment, Khalifa has stood against epistemic instrumentalism, according to which certain falsehoods would have direct epistemic value because of their active contribution to understanding (Sullivan & Khalifa, 2019). Instead, he has articulated a non-epistemic account where the value of falsehoods is explained by their convenience (Sullivan & Khalifa, 2019, p. 673): they alleviate problems associated with employing more accurate representations, either by simplifying computations or by highlighting features.

However, some idealizations are so deeply entangled in an explanation that they cannot be isolated. Even more, they may function to arrive at true answers, even if they do not constitute true answers in themselves. Insofar as they have some epistemic value, they must be understood as *approximately true*. In other words, they are on the right track of providing a full-fledged explanatory understanding. Khalifa understands approximately true explanations as follows:

> An explanation, q explains why p, is approximately true if and only if p is approximately true, and some of the terms in the explanans (q) that purport to make a difference to the explanandum (p) actually do make a difference and also satisfy your preferred ontological requirements. (Khalifa, 2017, p. 157)

The goal should consist in addressing one of the main criticisms raised by non-factivism against factivism: making sense of the epistemic role of approximately true explanations while maintaining veritism. For Khalifa, the root of the problem lies in the ontological dimension. Hence, it is necessary to dissociate veritism from any ontological commitment: from realism, because it denies the epistemic contribution of approximately true explanations (Khalifa, 2023, p. 44); from anti-realism,

because it leads to an extremely liberal notion where truth does not have a central role. To this end, Khalifa adopts an explanatory voluntarism, which allows the inclusion of both the idea of belief—associated with truth and realism—and acceptance—connected to effectiveness and non-realism. The latter demands reformulating the Scientific Knowledge Principle (EKS1b) to include both elements—i.e., belief and acceptance. We move from: "S has scientific knowledge that q explains why p if and only if the safety of S's belief that q explains why p is because of her scientific explanatory evaluation (SEEing)"; to: "S has scientific knowledge that q explains why p if and only if the safety of S's belief or acceptance that q explains why p is because of her SEEing" (Khalifa, 2017, p. 178). For Khalifa, to "accept that 'p'" is to have a policy of including that proposition among the premises for deciding what to do or think in a particular context. "Accepting 'p'" is effective if including p as a premise in inferential policies plays a significant role in achieving the goals at stake. Thus, nondoxastic acceptance can include false, implausible, or impossible statements as long as effectiveness is maintained. As a final step, he revisits minimal understanding to include acceptance, showing that idealized explanations that depart from the truth can contribute to understanding (Khalifa, 2017, p. 176).

According to him, inquisitive veritism is not threatened with this reformulation. Although the inclusion of acceptance within Scientific Knowledge allows us to grant certain epistemic role to idealized explanations, they do not enjoy a high-ranking status; these are on the track to full-fledged explanatory understanding. Certainly, veritism does not demand disapproval of nondoxastic acceptance of false propositions. In fact, it may encourage them both non-epistemically (as convenience tools) and epistemically (as proto-understanding). What it prohibits is *to believe* in false propositions. While understanding and truth do not always cooperate (2017, p. 154), Khalifa reminds us that falsehoods never provide explanatory understanding sensu stricto (2020). However, this analysis has internal tensions that result in the following scenarios.

Scenario 1. Veritism Is Weakened to Preserve Explanatory Voluntarism For Khalifa, there is a clear differentiation in the contribution of true, approximately true, and false explanations to understanding. In fact, he holds a gradation in understanding related to the approximation to an ideal understanding. By modifying the notion of scientific knowledge to include acceptance, Khalifa seems to blur this differentiation, thus weakening the intuitive idea underlying veritism. According to the latter, while the particularities of the context shape how the acceptance standard is implemented (given the explanations and methods/evidence available), its very existence is objective: the difference between true, approximate, true, and false explanations depends on how they approach the relevant factive state. For example, current cancer research provides the methods and evidence to evaluate the veridicality of the various available explanations for the most effective treatment. There are empirical facts that prove the truth of chemotherapy/radiotherapy/surgery (confirmed), the plausibility of therapies focused on tissue normalization (under exploration), and the falsehood of pseudotherapies (rejected). In short, there is an objective way to rule out crackpot explanations and determine which understanding most genuinely

approaches ideal understanding: attending to the relevant facts of the world. Khalifa believes that the inclusion of acceptance within scientific knowledge and the adoption of voluntarism makes it possible to account for the epistemic contribution of idealized explanations while granting veritism. Yet the differential status of truth is actually being blurred by eliminating its ontic counterpart: It is no longer clear on what the former differentiation is based. If truthful explanations are not epistemically valuable because they correctly point out certain key aspects of a reality that remain independent of us, where does its distinctiveness lie? Moreover, why should we keep veritism? Couldn't a non-factive approach do the same job? These considerations are illustrated by his anti-realist treatment of difference-makers—to prove explanatory voluntarism—, which is associated with empirical adequacy (Khalifa, 2017, pp. 157–158). However, we know that this notion has traditionally been raised against the notion of truth (e.g., Van Fraassen, 1980), setting the basis for the elaboration of non-factive proposals (e.g., Elgin, 2017).

Scenario 2. Explanatory Voluntarism Is Weakened to Support the Epistemological Differentiation Between True, Approximately True, and False Explanations If the aforementioned quandary is admitted, then it seems necessary to recognize that acceptance does not enjoy the same epistemic status as belief to grant understanding. To make sense of the latter, an ontological ascent seems to be needed, since otherwise we would be falling into epistemological considerations that would culminate in coherence and the threat of relativism. Although realism does not directly follow, certainly the most intuitive way would be to grant that belief is associated with the ability to successfully reference the elements of the ontic structure that stand independently. If not, Khalifa must show what alternative can account for this differentiation. The important point is that it is not clear that veritism and realism can be genuinely divorced.

In short, the attempt to combine veritism with explanatory voluntarism to save the epistemic role of approximately true explanations is unsatisfactory: either the veritistic commitment is weakened or explanatory voluntarism is abandoned (either by recognizing realism or some other ontological stance).

5 Conclusion

In this paper, I have argued that the veritist and realist theses are so intimately related that it is unfeasible to dissociate one from the other when formulating an adequate account of scientific understanding. In fact, traditional factive accounts of understanding have implicitly recognized this point by surreptitiously adopting both theses in their analyses. Bringing this intertwining into attention is worthwhile since recent proposals have tried to dissociate ontological and epistemological commitments. In other words, they have claimed that it is possible to adopt only one of the two theses, leaving aside the other. I have illustrated this point through the proposals of Potochnik and Khalifa. The former has articulated an account that renounces veritism while accepting realism. The latter has given up realism while embracing

veritism. I have illustrated the shortcomings of the first proposal through "the Representational Turn" and "the Inconsistent Analysis" arguments. I have evidenced the weaknesses of the second proposal through two other arguments: "the Meaning of Truth" and "the Inconsistent Analysis" arguments. In both cases, the conclusion was the same. Either both proposals are inadequate and should recognize that the realist and veritist theses are linked, or they acknowledge that they are incomplete and still have hard work to do to prove the feasibility of this dissociation. In sum, I have shown that it is still fair to claim that if one wants to articulate an account committed to a truth-centered epistemology, one should adopt a realist stance; if one wants to articulate a realist account of scientific understanding, one should adopt a truth-centered epistemology.

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