

## EXPLAINING AND UNDERSTANDING IN SCIENCE – PHILOSOPHICAL APPROACHES

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### Abstract

Scientific explanation was a major topic in philosophy of science meanwhile the subject of scientific understanding got little attention. For a long period the last one was considered to be subsumable under an approach on explanation. Recent developments are challenging this view. After presenting the evolution of the relation between the two subjects I will discuss the recent approaches on understanding and some critical reactions they triggered. I will take sides by defending the value and novelty of the recent investigations on the topic of scientific understanding.

**Keywords:** *scientific explanation, scientific understanding, explanation with and without understanding*

Explaining and understanding are important cognitive achievements not only for communication processes in general but for scientific inquiry and science communication in particular. The topic of scientific explanation was at the center of the debates in philosophy of science for a long period during the second half of the last century. The subject of understanding was on the contrary a quite neglected one. The recent developments and tendencies are changing this situation. After tracking the historical evolution that built up the received view, I will discuss the recent developments that tend to reconfigure the relation between explanation and understanding. In the last part I will defend the position of the friends of understanding against the recent critiques from a reductionist position.

### THE GLORIOUS TRADITION OF THE EXPLANATION TOPIC AND THE HUMBLE ONE OF UNDERSTANDING

One might trace the preoccupation for explanation more or less implicit in different moments of the history of philosophy but the real glorious story of the topic began in the mid

of the XXth century in the frame of the influential philosophical orientation of logical positivism. There was also a time when philosophy of science enjoyed more recognition than ever in the English speaking philosophical world, its subjects being connected to important topics from the main disciplines of the analytic philosophy such as epistemology, logic or metaphysics. The successful story starts with the deductive-nomological (DN) model of scientific explanation proposed by C.G. Hempel, one of the major figures of this orientation. The model is one of the finest achievements of the neopositivist conception of science, concentrating many of the main desiderata of its anti-metaphysical and reductivist project.<sup>1</sup> The anti-psychologist attitude is also one of the characteristics of this program and it concerns us directly here due to its direct impact on the subject of understanding. In Hempel's words: "such expressions as 'realm of understanding' and 'comprehensible' do not belong to the vocabulary of logic, for they refer to psychological or pragmatic aspects of explanation"<sup>2</sup>. So, understanding was identified as belonging rather to the subjective dimension of the explanation than to the objective one, and therefore not an object of logico-philosophical investigation.

According to Hempel's model, explanation was an argument whose conclusion was the explanandum – i.e. the event to be explained, and the premises must include some general laws and a set of conditions that describe the situation under which the phenomenon occurs. The occurrence of the phenomenon is explained this way by subsuming it under general laws or uniformities. In what regards the understanding provided through an explanation, the few remarks describe it in terms of a nomic

expectability – i.e. the researcher would have expected the occurrence of the phenomenon. In another place Hempel claims that the understanding is expressed through the researcher's insight in how the phenomenon fits into the network of laws and generalizations. This last characterization was taken as the central aspect of understanding in one of the influential approaches that succeeds the DN model – the unificationist approach proposed by Friedman and later developed by Kitcher.

Attempts to give scientific understanding a better place in philosophical analysis of science were made from the very beginning of the debate around Hempel's model by some philosophers such as Michael Scriven, St. Toulmin or William Dray. Scriven remarks the importance of understanding for explanation<sup>3</sup>; while Toulmin sees explanation and understanding involving reduction to some "ideals of natural order" and Dray takes reduction to familiarity as the main mark of the way explanation provides us understanding. Nevertheless such attempts were not further researched in the face of the success of the DN model which led to the ban of the understanding topic from the philosophical agenda.

Michael Friedman was the author that dared to reclaim the importance of understanding for the explanation subject by acknowledging also the importance of a detailed explanation analysis as Hempel's one. Friedman sees all the previous mentioned attempts to analyze understanding as independent and disconnected from a real analysis of explanation. He closely connects such an analysis with an insight into understanding and requires that an approach on explanation should isolate an objective sense of the explanatory relation that should have a clear connection to understanding. For Friedman and later Kitcher this sense is captured by unification<sup>4</sup>. In Friedman's view the unification takes place by deriving specific laws that govern particular phenomena (for example Galileo's laws for the falling bodies or Kepler's for celestial bodies) from more fundamental laws (for example from the laws of the Newtonian mechanics). This way our understanding is increased "by reducing the total number of independent phenomena"

(expressed previously through these local laws) that "we have to accept as ultimate or given"<sup>5</sup>.

Friedman also gives expression in his approach to an attitude towards the subject of understanding that will be largely accepted in the subsequent developments. We might call it as Khalifa does, the 'redundant view'. Under this view any approach on understanding is redundant on an analysis of explanation. Any independent or direct approach on understanding is denied: "It is not reasonable to require that a theory of explanation proceed by first defining 'scientific understanding' and then showing how its reconstruction of the explanation relation produces scientific understanding. We can find out that scientific understanding consists in only by finding out what scientific explanation is and vice versa"<sup>6</sup>.

So, according to this view, we do not have any direct access to understanding but only via an analysis of explanation and that justifies why we hardly could find any reference to understanding in the subsequent debates. Such accounts as Salmon on causal explanation or the pragmatic one of van Fraassen follow this trend. The possibility of coexistence of different accounts of explanation, as the unificationist and the causal one (pleaded by authors as Salmon) unveils also the possibility of different forms of understanding – as the understanding provided through unification and the one provided through causal explanation. The first one is the understanding at a global level delivered through the process of unification of various phenomena under a small number of laws; the other one constitutes the sort of understanding gained by spelling out the causal local network that produces the phenomenon. Nevertheless the possibility and consequences of a variety of modes of understanding were not really taken seriously into account till recently.

## **SHIFTING VIEWS, NEW PERSPECTIVES**

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The eighties could be seen<sup>7</sup> as a time when the debate on explanation reached a turning point resulting in radically new views. Major new accounts were advanced as the ones already mentioned proposed by Salmon, Kitcher or van

Fraassen resetting completely the old agenda that was centered on the debates around Hempel's model. This intense debate was followed by a period characterized by a decreasing interest in the topic, a sort of fatigue manifested by the philosophers in dealing with this subject making some philosophers to characterize the topic as an "embarrassing"<sup>8</sup> one for the discipline. The great expectation of the initial program to get a clear unified model of scientific explanation shattered against the multiple problems encountered.

But the recent period marks also a sort of tacit resettling of the assumptions and requirements for the explanation topic. Starting in the last decade of the XXth century and continuing in the next one some philosophers of science came to regard the subject of explanation and understating in a more "relaxed" way. This "relaxed" way is to be understood through the fact that the strong assumptions and constraints imposed by the old project were abandoned.

This old project was elaborated in the frame of the received view that shaped more generally the scope and methods of philosophy of science and in which the logical positivism played an important part. This view involves the elaboration of a grant view of science and the description of a unique scientific methodology that should be valid for all areas of science.

Against this received view, Nick Hugget contraposes the new tendency that became obvious in the last period and which he characterizes as promoting a sort of 'local' approaches. This tendency involves the development of more "local philosophies of science" meaning by this that the aim of the research is to address particular issues and questions that are raised in the frame of well-delimited scientific programs, rather than to impose some grand view of science elaborated through philosophical analysis<sup>9</sup>. This particularization of the working agenda to specific areas promotes also a greater sensitivity to scientific practices.<sup>10</sup> In this context more consideration is given to some elements that were previously neglected and dismissed in the philosophical analysis of science. Such are for example the experimental activities, models and the modeling processes or the role of various

types of representation that are not directly linked or derived from an accepted scientific theory.

This new research context brought also a reevaluation of the subjects of explanation and understanding and of their relation. One reference that is worth mentioning in this sense, though not directly influenced by the above-mentioned changes but contributing to the change of the attitude towards understanding, is the account developed Schurz and Lambert. In this account for the first time we are given a theory of scientific understanding not via an analysis scientific explanation, but through a direct approach, challenging this way Friedman's view. For Lambert and Schurz to understand a phenomenon P is to assimilate it into a corpus of knowledge K by providing an answer to the question how does P fit into K. The assimilation goes through an inference (taken in a board sense) which links P to the other accepted statements from K.

What is to be emphasized here for our exposition is that understanding is not any more taken as an implicit by-product of an explanation analysis, but the other way around. Lambert & Schurz approach marks a radical departure from the traditional assumption, still widely accepted at that time. Unfortunately Lambert and Schurz account is still seen as a variant of the unification approach on explanation overlooking this way the change in accent that took place.

The rise of the new tendencies in philosophy of science as characterized earlier made it easier to find voices calling for a direct and independent approach on understanding topic.

## **THE RECENT APPROACHES ON UNDERSTANDING AND ITS CRITIQUES**

Before proceeding to the recent developments in philosophy of science we have to mention an interesting parallel development taking place in a nearby philosophical discipline, in epistemology. A few epistemologists engaged in arguing for a resettling of the old problems by drawing the attention to the value if understanding for epistemological issues. Kvanvig for example argues for a new solution to the classical problem

form Plato's *Meno* by moving the reference from knowledge to understanding, while Riggs argues for putting understanding in a similar role as *eudaimonia* taking it as the aim of exercising the intellectual virtues. Another important epistemologist, Linda Zagzebski drawing on specific interpretations of Plato's texts, advances the idea of taking the concept of *episteme* as referring rather to understanding than to knowledge and further conceiving it as being acquired through the process of learning an art or a skill. The mentioned developments though not directly linked to the debates in philosophy of science, did sensitize the philosophical attitude towards the topic of understanding. They contribute to the reconfiguration of this attitude at a larger scale beyond the strict limits of the specialized fields of research.

Turning to philosophy of science, the last decade registered indeed a rise in interest for the subject of understanding. One could distinguish more directions in which the research on the subject is moving. One of the preoccupations seeks to articulate a general theory of scientific understanding or at least to identify some guiding lines to be followed into such an articulation. Another direction concerns the relation of understanding with explanation aiming also to clarify the relation between the old analyses of explanation and the new investigations on understanding. Yet another direction seeks to investigate and isolate important characteristics of how understanding is gained in particular situations, in specific areas of scientific research. Nevertheless this is only a rough way to distinguish among different aims of the actual research on understanding. I will limit myself in this text to present and discuss only the major theories that were offered and the critical reactions that they triggered.

In the next paragraphs I will present and take as reference two major approaches on understanding: Grimm's and de Regt's. de Regt's conception of understanding is a pragmatic one rejecting what he calls the 'objectivist' sort of approach as Friedman's, that assumes that an analysis of understanding can be rendered through "objective algorithmic procedures". For de Regt what is essential in understanding and was ignored in objectivist approaches is to be

found in the skill register. He points to the skills developed by using some theory in order to build models for explanations. In his pragmatic approach to understanding developed together with Dieks, de Regt separates the understanding of a theory from the one of a phenomenon (P), the first one being linked to the ability to use that theory meanwhile the last involving the explanation of the phenomenon. In order to build the last, one needs the first, so that understanding P is defined as having an intelligible theory to account for it. The intelligibility of a theory in a context is further unpacked to involve recognizing qualitative consequences of the theory without performing detailed calculations. In the next paragraphs I will be concerned with the general critiques advanced by the skeptics that aim to reject this account in particular but also the more general philosophical way of approaching the subject of understanding.

A different construal that was advanced by some authors involved in the debate takes understanding to be simply the "grasping" of an explanation. The further efforts concentrate on unpacking how grasping should be understood. For Grimm, grasping is rendered in terms of a "fallible exercise of his [one's] capacity for seeing dependencies"<sup>11</sup> in which the cognitive subject is not only "passively taking in the world as it unfolds before him"<sup>12</sup> but is "reaching out towards understanding the dependency in a new and distinctive way."<sup>13</sup> In a recent paper Strevens proposed another mode of analyzing grasping by distinguishing between understanding that and understanding why involving the grasping of the represented state of affairs and the explanatory structure between the propositions involved. Strevens situates his view more on a reductionist perspective on understanding, a position that I will discuss a bit later.

Now turning to the critical reactions towards these new developments on the understanding subject, I will consider only the boldest ones. A vigorous reaction to de Regt's theory in particular and to any philosophical sort of approach more general was voiced by Trout. His critique builds on a naturalist position, a conception that takes philosophical problems as tractable through the methods of the empirical sciences. For Trout the

philosophical approaches on understanding are totally misguided since they cash on a sense of understanding given through two psychological biases, which are well documented in cognitive psychology. These are the hindsight bias and overconfidence. The hindsight-bias is expressed by "I-know-it-all-along effect" in which people tend to overestimate how probable the event was before it occurred. It gives us a false understanding of an effect and makes us regard the search for an explanation as complete. Overconfidence makes us overestimate the correctness of our beliefs. As an effect, it could also prompt a stopping rule for pursuing further explanatory inquiry. Philosophical approaches provide us a false meaning of understanding that draws more on the subjective feeling of understanding. This distinction between the deviant 'sense of understanding' and the genuine understanding was taken into consideration by some philosophers<sup>14</sup> and is the major moral that can be retained from this critique.

Another bold critique was formulated by K. Khalifa in two recent papers. His argumentation aims to show that the recent advanced analyses of understanding could be reduced to some consequences of the previous research on explanation. From a more general perspective one can see that Khalifa expresses an existing reticence of some philosophers of science towards the topic of understanding. I will shortly present the main lines of his critique and try to reject it by exposing the main points where it fails.

In the first paper Khalifa argues for the EMU thesis which states that any philosophical relevant ideas about scientific understanding can be captured by the epistemology of explanatory knowledge and so it suffices to follow the approaches on explanation. In order to do this he proceeds to show how the existing accounts on understanding are better considered to fall under the EMU thesis rather to be taken as inaugurating a new field of research. He takes as reference Grimm's approach and de Regt & Dieks' account, separately treating some of de Regt's ideas as a distinct approach. In case of Grimm's account Khalifa qualifies it "to be little more than a consequence of Woodward's analysis of explanation". For Woodward explanations are answers to questions of *what-if-thing-had-been-different* involving counterfactual inferences.

According to Khalifa, Grimm's construal of understanding as anticipating how changes in one variable affects another, constitutes only a continuation of Woodward's analysis, emphasizing more the mental aspects and cognitive abilities involved in the explanation process. In case of de Regt account Khalifa takes on both the general view on understanding as involving skills and on the specific conditions from the de Regt & Dieks' account. Khalifa's arguments aim this way to reset the entire development in the old frame of the redundant view so that research on explanation will suffice to tell us everything philosophical interesting about understanding.

A second line of attack developed in a separate paper is aiming to downplay Lipton's radically new suggestions on understanding, one that decouples totally understanding from explanation. Khalifa targets the ideas suggested by Lipton who pleads for taking seriously the possibility of non-explanatory modes of understanding. Khalifa's argumentation aims to show that such modes of understanding "ought to be assessed by how well they replicate the understanding provided by good and correct explanation"<sup>15</sup>. He backs this way a position he calls explanatory idealism which claims that explanation is the ideal of understanding. This second argumentation comes to complement the first critique by closing the gaps left from the first one and bringing any existing approach on understanding in the scope of the explanation topic.

I will end my paper suggesting some ways to refute Khalifa's attack and backing the attitude that emphasizes the value and novelty of the research on understanding. I will first begin with his reduction of the existing approaches on understanding to a mere consequence of the explanatory accounts. The first observation concerns the targets he picks as the only analyses of understanding- the accounts of Grimm and de Regt. It is strange that Khalifa ignores Lambert & Schurz account, one of the best articulated. One might guess that this account could be taken by Khalifa as backing the EMU thesis by being subsumable under the unification approach on explanation. Putting aside this omission one can see that Khalifa is concerned only with the few

general theories of scientific understanding. But the literature on understanding is much richer with more applied analyses investigating how understanding is gained in particular scientific situations<sup>16</sup>. These analyses are not to be ignored since they might capture in a better way the ongoing investigation effort. They could be seen as having an exploratory character and eventually paving the way to a more comprehensive general theory of scientific understanding. These inquiries are more in the spirit of the “local philosophies of science” and fit the new tendency of philosophy of science in practice. But Khalifa’s critique ignores entirely these local investigations leaving open the possibility that such analyses could bring more than the general accounts on scientific understanding.

Turning now to Khalifa’s critique, the most obvious failure of his argumentation occurs in regard to de Regt’s position. In his first analysis he aims to reject de Regt general view that draws on skills as the main characteristic of understanding. Khalifa’s intention is to show that the skill condition is totally captured by a classical account on explanation and in order to do this he amends de Regt discussion of Hempel’s account. At the bottom line his argumentation forces the equivalence between skills and explicit propositional knowledge expressed through the explanatory links given in the explanans. The move is not really plausible and Khalifa does not provide any argumentation to back it. Skills are better characterized by a sort of tacit knowledge and are therefore not translatable without rest into explicit knowledge. In our case the skills resulted from using and applying a theory do not reduce to the explicit propositional knowledge that spell out the inferential links of an explanation. The take on de Regt’s account remains unsubstantiated at best if not in a good sense missing its target.

In his second critique Khalifa proceeds to argue against the importance of inquiring the suggested alternative modes of understanding. Lipton’s proposes to identify understanding with the benefits of an explanation rather with the explanation itself. These benefits are seen in terms of knowledge of necessity, possibility, causality or unification.<sup>17</sup> This move allows Lipton to further look for other ways than

explanation to get these benefits. He considers such means as potential but not actual explanation, non-explanatory deductive arguments, different sorts of models, visual means or causal manipulations. Lipton’s suggestion seems to open an entire new field of research into the understanding topic justifying and promoting the search for more local sorts of understanding that could be instantiated in a variety of particular situations.

One might rightly accuse Khalifa of missing Lipton’s point<sup>18</sup>. Khalifa actually recognizes the existence of such modes of understanding; his argumentation rather aims to restate the guiding role of explanation. Nevertheless it remains entirely open in what sense the alternative modes of understanding have to be “assessed” in relation to the explanation-based understanding. His strategy of argumentation shows actually that a correct explanation provides ‘greater’ understanding than any alternative mode of understanding. But this strategy is based on a narrow explication of understanding which strictly identifies understanding with the cognitive benefits given through a correct explanation. His argumentation shows that the benefit expressed through an alternative mode of understanding is to be included in the larger set provided through the correct explanation.

There are many weak points in his argumentation and I provided a detailed analysis elsewhere<sup>19</sup>. The major unjustified move lies in the “friendly articulation of Lipton’s Assumption”. In his reading Khalifa imposes the existence of a correct explanation that will subsume under its benefits any alternative understanding. But Lipton’s text leaves open such a reading and it does not imply the existence of a such an explanation.

Another disputable point involves the above mentioned narrow reading of the “assessment” of any alternative mode of understanding. The benefits provided by an alternative mode of understanding, say a potential explanation, might not be totally subsumed under the set provided through a correct explanation but intersect partially this set. In fact the last situation seems to better capture the situation. It is therefore improper to impose a comparative reading in terms of the sets of cognitive benefits.

In the end it is to be mentioned that Khalifa's reductive view, without denying the existence of such alternative modes of understanding, ignores their role and importance for the study of scientific practice. These modes could give us a better insight into the way scientific knowledge is produced than only referring to the end product – the final explanation. Lipton's suggestion for looking at such alternative modes goes therefore much more in the direction of a more local investigation a more applied one that considers the dynamic and the ways knowledge is produced promoting a closer contact with the working scientist and the scientific practice.

Before concluding we might say that despite the failure of the critiques that aimed to reject the new investigation into understanding, these reactions brought some interesting questions to the working agenda. From Trout's critique one could retain the issue of the separation between the genuine forms of understanding and the fake ones. This might be a valuable distinction in some situation as the one analyzed by Kuorikoski in case of understanding gained through computer simulations. Khalifa's critique raises also some important questions for the further inquiry on the understanding topic. One points to the relation between the existing analyses of scientific explanation and the way these might be useful for inquiring into at least some forms of understanding. A more radical question concerns the relation between the alternative modes of understanding and the explanation-based understanding. One clarification can go in the direction of properly qualifying the "explanatory idealism" and the way it can be claimed. A more concrete question might target the way alternative modes of understanding contribute to the articulation and the fixation of correct explanations. I see therefore a quite rich range of issues that could be raised in connection to such an agenda, particularized at different scientific situations.

## CONCLUSIONS

I have tried to present synthetically the evolution of the topic of scientific understanding ending up with the recent interesting debate

around it. As presented the subject did not find any important place on the working agenda of philosophers of science for a long time. This situation could be explained through the legacy of the influential philosophical orientation that brought philosophy of science at the front stage of the philosophical preoccupation in the mid of the last century. In this frame the topic of scientific explanation was supposed to entirely account for the issues related to scientific understanding. At the end of the century the classical philosophical view on science began gradually to be replaced by alternative ways of approaching science. In the new context the subject of understanding attracted the attention of philosophers and few approaches independent of any explanation analysis emerged. Of a major interest is first of all the relation of understanding to explanation which might influence how the subjects might be approached. I presented the different options available and brought arguments to defend a direct approach. Despite the few skeptical positions regarding an inquiry into understanding the subject of scientific understanding proves to be of high interest for the philosophers of science, opening an entirely new area of research.

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### Endnotes

1. The interested reader can find a good exposition of the model and the debate around it in Salmon's book, *Four Decades of Scientific Understanding*.
2. Hempel, *Aspects of Scientific Explanation and other Essays in the Philosophy of Science*, p. 413.
3. "Whatever an explanation *actually* does, in order to be called an explanation at all it must be *capable* of making clear something not previously clear, that is, of increasing or producing understanding of something" writes Michael Scriven in his contribution "Explanations, Predictions, and Laws", p. 175.
4. For a synthetic exposition of Friedman and Kitcher accounts I will recommend again Wesley Salmon's excellent book on the history of the explanation debate *Four Decades of Scientific Explanation*.
5. Friedman, "Explanation and Scientific Understanding", p.15.
6. *Ibidem*, p. 6.
7. As presented in Salmon's book *Four Decades of Scientific Explanation*.
8. Newton-Smith in the entry on explanation in *A Companion to the Philosophy of Science*.
9. As stated by Huggett: "philosophical problems are to be found and treated using the resources of more-or-less delineable scientific programs" and "not by trying to make science fit some prior vision".
10. The recent organization of mostly young philosophers of science in a *Society of Philosophy of Science in Practice* gave this tendency a clear organizational frame.
11. Grimm, *Understanding as an Epistemic Goal*, p 79.
12. *Ibidem*, p 80.
13. *Ibidem*, p 80.
14. Such as Kuorikoski in Kuorikoski, J. (2011), "Simulation and the Sense of Understanding", in Paul Humphreys and Cyrille Imbert (eds), *Models, Simulations, and Representations*, London: Routledge.
15. Khalifa, "The Role of Explanation in Understanding", p.161.



16. Most contributions are of these sort in the volume edited by de Regt, Henk W., Sabina Leonelli, and Kai Eigner (2009) *Scientific Understanding: Philosophical Perspectives*. Pittsburgh: University of Pittsburgh Press.
17. We could see here the influence of the explanation accounts that explicate explanation in these terms.
18. As de Regt does in a forthcoming paper: de Regt, H. W. (2012) "Understanding and explanation: Living apart together?" in *Studies in History and Philosophy of Science*, <http://dx.doi.org/10.1016/j.shpsa.2012.12.002>
19. In a forthcoming paper to appear in the journal *Logos & Episteme*.