A Hybrid Account of Scientific Progress: Finding Middle Ground Between the Epistemic and the Noetic Accounts

Clara Goebel

Abstract

Whereas the progressive nature of science is widely recognised, specifying the standards of scientific progress has been subject to philosophical debate since the enlightenment. Recently, Ilkka Niiniluoto, Alexander Bird, and Finnur Dellsén have revived this debate by setting forward a semantic, epistemic and noetic account of scientific progress respectively. I argue that none of these accounts is satisfactory. The semantic and epistemic accounts might advance necessary conditions for scientific progress, namely an accumulation of true, justified, and non-Gettiered beliefs, but fail to specify sufficient conditions. The noetic account, in contrast, advances sufficient conditions for scientific progress, namely an increase of genuine understanding, but fails to specify the necessary conditions. To remedy these deficits, I advance a hybrid account of scientific progress between the epistemic and noetic accounts, according to which the accumulation of explanatorily or predictively powerful knowledge constitutes scientific progress. In contrast to the epistemic account, my account ensures that only scientifically relevant knowledge constitutes scientific progress, thereby evading the threat of underdemandingness. In contrast to the noetic account, my account does not impose a psychological requirement of grasping the explanatory or predictive power of a scientific development, thereby evading the threat of overdemandingness. A further advantage of my account is that it can preserve plausible features of the noetic account.

Keywords: *scientific progress, knowledge, understanding, explanatory power, predictive power, the aim of science*

Intuitively, one of the features which distinguishes the sciences from non-empirical disciplines, such as philosophy or art, is their progressive nature: We take it that, in the sciences, there exist objective standards which determine when and why certain scientific developments

Kriterion – Journal of Philosophy, 2019, 33(3): 1–16.
http://www.kriterion-journal-of-philosophy.org

constitute an improvement on what came before. The specification of these standards has been subject to philosophical debate since the 1600s. Whereas enlightenment philosophers widely accepted a realist epistemic account of cognitive scientific progress, their account came under attack by antirealists, such as Thomas Kuhn, during the 1960s. This has given rise to the contemporary debate, which largely revolves around realist accounts of scientific progress, namely the semantic, epistemic, and noetic account. The semantic account (most notably, see [17] and [19]) seems to provide an obvious solution to the question of scientific progress: Scientific progress occurs when we accumulate true beliefs or, at least, verisimilar beliefs. On inspection, however, we might think that an accumulation of mere true beliefs does not suffice for scientific progress. Rather, scientific progress requires an accumulation of knowledge, i.e. non-Gettiered justified true beliefs. This is the view of the epistemic account (most notably, see [1]). If we further examine this account, however, we might again think that our scientific interests do not consist in accumulating knowledge, but rather in correctly explaining observables and reliably predicting phenomena. This leads to the noetic account (most notably, see [4]), according to which scientific progress occurs when a scientific development features an increase in understanding, i.e. the scientist's capacity to grasp the explanatory and predictive consequences of a scientific development.

In this paper, I argue that none of these accounts is satisfactory. The semantic and epistemic accounts are underdemanding with regard to scientific progress, i.e. they count certain developments as progressive, which intuitively do not constitute scientific progress. The noetic account, in contrast, is overdemanding with regard to scientific progress, i.e. it fails to count certain developments as progressive, which intuitively do constitute scientific progress. To remedy the deficits of the semantic, epistemic, and noetic accounts, I attempt to set forth a realist hybrid account of cognitive scientific progress which occupies middle ground between the epistemic and the noetic accounts. According to my hybrid account, the accumulation of explanatorily or predictively powerful scientific knowledge constitutes scientific progress.

In section 1), I specify more closely the conditions of scientific progress as postulated by my hybrid account, namely i) the accumulation of scientific knowledge and ii) the explanatory or predictive power of such knowledge. Given this characterisation of my hybrid account, I will make some brief remarks regarding what promotes scientific progress versus what constitutes scientific progress. I will also make some brief

remarks regarding the rate of scientific progress. In the subsequent sections, I attempt to defend my hybrid account: in section 2), I discuss the criterion ii) of explanatory or predictive power and demonstrate in what way it renders my hybrid account more plausible than the noetic and the epistemic accounts. In section 3), I discuss the criterion i) of the accumulation of scientific knowledge and demonstrate in what way it renders my hybrid account more plausible than the semantic account. Finally, in section 4), I demonstrate how the criterion of explanatorily or predictively powerful knowledge enables us to preserve plausible features and implications of the noetic account.

1 A Hybrid Account of Scientific Progress

According to my realist hybrid account, two conditions are individually necessary and jointly sufficient for cognitive scientific progress, namely i) the accumulation of scientific knowledge and ii) the factual explanatory or predictive power of such knowledge.

i) constitutes an epistemic desideratum for scientific progress: scientific progress must involve an accumulation of scientific knowledge, i.e. an accumulation of non-Gettiered justified true beliefs. Such knowledge need not be positive (p), it may well be approximate knowledge (approximately, p), negative knowledge ($\neg p$), hypothetical knowledge ($p \rightarrow q$), and so forth. Furthermore, the KK principle need not obtain. According to the KK principle, for any proposition p, if one knows that p, then one knows that one knows it. However, in the case of scientific progress, for any proposition p, if the scientist knows that p, then the scientist need not know that she knows it.

ii) constitutes a pragmatic desideratum for scientific progress: the accumulated scientific knowledge must possess explanatory or predictive power. The reason for this is that only knowledge with explanatory or predictive power can be scientifically relevant in a broad sense: Only knowledge which enables or provides (even simple) explanations or predictions satisfies our curiosity about the world, the institutional embodiment of which is science. The explanatory power of a proposition or theory amounts to its ability to adequately explain real phenomena. These explanations can range from quite simple to very sophisticated explanations. In a straightforward case, the existence of a previously unknown planet explains our observing an uncharted orb[1]. In a more complex case, collision theory explains the course of chemical reactions. Ideally, the theory in question allows for effective explanations. That is,

it is either simpler when compared to preceding theories (see [7]) or it explains a larger set of observables and, thus, offers greater unification power (see [10]). The predictive power of a theory amounts to its ability to enable or provide accurate predictions of real phenomena. Ideally, the theory in question allows not only for accurate predictions, but for striking predictions (see [15]).

The ability of a proposition or theory to adequately explain observables and provide accurate predictions implies its well-integratedness within a larger well-established scientific context or structure. On the one hand, well-integratedness concerns the content of the proposition or theory and how neatly it fits with other well-established findings of the scientific discipline. On the other hand, well-integratedness concerns the method and principles of scientific inquiry employed in the development of a proposition or theory and whether these are sufficiently accredited within the network of sciences (see [23]).

As with the epistemic desideratum, the scientist need not be aware of the explanatory and predictive power of the accumulated knowledge or able to substantiate its explanatory and predictive consequences. In other words, my hybrid account (as opposed to the noetic account) does not impose a psychological requirement of grasping the explanatory or predictive power of a scientific development. It merely requires that a scientific development does, in fact, possess explanatory or predictive power. The reason for this shall be attended to in section 2), where I discuss the advantages of my hybrid account over the noetic account. Given that there is neither an awareness requirement on the epistemic desideratum i) nor on the pragmatic desideratum ii), in some cases, scientific progress may only be recognisable in hindsight.

At this point, one might ask wherein the difference lies between the explanatory or predictive power of a scientific development, which I appoint as the marker for scientific relevance, and the problem-solving power of a scientific development, which Kuhn and Laudan appoint as the marker for scientific progress (see [12] and [16]). Functionalist-internalist accounts, such as Kuhn's or Laudan's account, make two claims which I do not intend to make: firstly, they require that the scientist is in the epistemic position to judge whether a relevant function has been fulfilled by a scientific development. On my account, however, the scientist need not be able to judge this. Secondly, functionalist-internalist accounts are antirealist stances. Antirealists about scientific progress reject an accuracy standard of any kind as a criterion for scientific progress: Whether or not a scientific development constitutes

progress cannot (as realists would claim) be determined by appeal to external, mind-independent standards, such as its truth and, relatedly, its justification, explanatory power, or predictive power. Rather, whether or not a scientific development constitutes progress is determined by comparison to the existing paradigm, independently of its accuracy. My account, in contrast to functionalist-internalist accounts, is a realist stance. However, if we jettison the psychological requirement of being able to grasp the problem-solving power of a scientific development and, moreover, if we interpret problem solving within a realist framework, the phenomenon of problem solving seems to largely converge with the phenomenon of explaining observables and providing accurate predictions (see [5]).

Given this characterisation of my hybrid account, what might we say about the phenomenon of promoting scientific progress versus constituting scientific progress? Presumably, certain occurrences, such as technological advancements or increased funding for research, promote scientific progress although they do not constitute cognitive scientific progress (see [4]). Equally, certain instances of scientific knowledge sans explanatory or predictive power, such as collections of data regarding familiar entities, may promote scientific progress but by themselves do not constitute scientific progress. Such data does not constitute scientific progress because, taken on its own, it is scientifically irrelevant. However, the collection of data regarding familiar entities may well promote scientific progress because typically we engage in the accumulation and systematisation of data in the anticipation that we may prospectively derive explanatorily or predictively powerful theories from the data in question. Similarly, accidentally true beliefs with explanatory or predictive power may promote scientific progress but do not constitute scientific progress. Such beliefs promote scientific progress by prompting the scientific community to undertake further investigations in order to properly justify the beliefs in question (see [2]). It is, then, successful investigations of this kind which constitute scientific progress.

Furthermore, based on my hybrid account, what might we say about the rate of scientific progress? Broadly speaking, it seems that the degree of scientific progress hinges upon the degree of explanatory or predictive power rather than the amount of accumulated knowledge: the accumulation of a great volume of knowledge with little explanatory or predictive power seems to constitute less scientific progress than the accumulation of a modest volume of knowledge with exceptionally great explanatory or predictive power. We might say that positive knowledge (p) will

typically possess greater explanatory or predictive power than approximate (approximately, p) negative knowledge, ($\neg p$), and hypothetical knowledge ($p \rightarrow q$)[2]. Thus, positive knowledge will typically constitute greater scientific progress than approximate, negative, or hypothetical knowledge. Moreover, we might say that increases in our ability to detect and substantiate the explanatory or predictive power of a scientific development, i.e. increases in the depth of our understanding, translate into greater scientific progress than mere increases in factual explanatory or predictive power (see [1]). Given the latter intuition, it seems my hybrid account cannot account for the rate of scientific progress on its own. Thus, an additional account of the rate of scientific progress may be needed.

2 The Hybrid Account versus the Noetic and Epistemic Accounts

In this section, I attempt to demonstrate in what way the previously delineated condition ii) that a piece of scientific knowledge must be explanatorily or predictively powerful in order to constitute scientific progress renders my hybrid account more plausible than the noetic account and the epistemic account.

I shall begin by discussing why my hybrid account, in contrast to the noetic account, does not impose a psychological requirement of grasping the explanatory or predictive power of a scientific development, but merely imposes the requirement that a scientific development does, in fact, possess explanatory or predictive power. According to the noetic account, scientific progress involves increases in scientific understanding. There is substantial disagreement over the concept of understanding. On one account, understanding is factive, i.e. a species of knowledge (see [1])[3]. According to this account, having understanding of a subject matter involves that our beliefs concerning the subject matter are true, justified, and non-Gettiered. At the very least, our beliefs regarding the core of the subject matter must be true and justified, whereas peripheral beliefs may be untrue or unjustified (see [13]). On another account, understanding is merely quasi-factive (see [4])[4]. According to this account, understanding does not require knowledge or justified true belief. Arguably, understanding must not even involve a belief that some proposition p is true. Rather, we may merely assume or accept p to be true. On both the factive and quasi-factive account, however, understanding involves the capacity to adequately place some proposition p

into a larger context or structure (see [9], [13], and [24]). We might do so, for example, by identifying the relationship of p to other (adjacent) propositions, specifying its function in the structure of the whole, identifying the preceding and subsequent causal chains, and so forth. Such conceived, understanding some proposition p allows us to harness p for explaining observables and making accurate predictions (see [4]).

Regardless of whether the factive or quasi-factive account of understanding obtains, I argue that the noetic account is overdemanding with regard to scientific progress. According to the noetic account, a scientific development constitutes scientific progress iff i) we accumulate knowledge (or we accumulate true beliefs, or assume the truth of some proposition) and ii) we are able to adequately place the piece of knowledge (or the belief, or the proposition) into a larger scientific context or structure. The condition ii) amounts to a psychological requirement of being aware of and able to substantiate the well-integratedness of a piece of knowledge, its explanatory power, and its predictive power. Such a psychological requirement of grasping, however, renders the noetic account overdemanding: the noetic account cannot accommodate cases in which we accumulate knowledge with factual explanatory or predictive power, but are not (yet) aware of or able to substantiate its explanatory and predictive consequences. As an example, consider John Newland's proposal for a periodic table in 1864. Newland accurately observed that, when chemical elements are listed in order of increasing atomic weight, similar physical and chemical properties recur at periodic intervals of eight. He, thus, proposed the so-called Law of Octaves. Despite Newland's knowledge concerning the periodicity of properties in chemical elements, he did not recognise that the gaps and trends of his periodic table could be employed to predict the existence and properties of hitherto undiscovered chemical elements. Only Dmitri Mendeleev recognised the predictive power of the periodic table a few years later. Intuitively, cases such as Newland's discovery of the periodicity of properties in chemical elements seem to constitute scientific progress. It seems counterintuitive to say that the periodic table which Newland proposed in 1864, despite its truth content and sufficient justification, made for scientific progress only a few years later, when Mendeleev additionally grasped its predictive power. According to the noetic account, however, cases such as Newland's discovery of the periodicity of properties in chemical elements cannot constitute scientific progress because the scientist does not (yet) grasp the explanatory and predictive power of the scientific development in question. In order to avoid this counterintuitive implication,

when we attempt to identify scientific progress, we must jettison the psychological requirement of the noetic account. My hybrid account avoids the counterintuitive implication of the noetic account because, instead of imposing a psychological requirement of grasping the explanatory or predictive power of a scientific development, it merely requires that a scientific development does, in fact, possess explanatory or predictive power. Given that Newland's periodic table did, in fact, possess predictive power, his knowledge concerning the periodicity of properties in chemical elements constitutes scientific progress according to my hybrid account.

I shall now discuss why my hybrid account, in contrast to the epistemic account, requires that scientific progress involves the accumulation of scientific knowledge with explanatory or predictive power. According to the epistemic account, scientific progress involves the accumulation of scientific knowledge (see [1]). In contrast to the noetic account, this account demands too little with regard to scientific progress. According to the epistemic account, cases in which we accumulate scientific knowledge without explanatory or predictive power, i.e. scientifically irrelevant knowledge, constitute scientific progress. Scientifically irrelevant knowledge might, for example, include collections of data regarding regarding familiar entities, random experimental outcomes, hypothetical knowledge which relies on absurd or highly doubtful premises, or statistical correlations sans causation. For example, it is scientifically established that there is a correlation between the age of Miss America and the number of murders by steam, hot vapors, and hot objects. Intuitively, however, such instances of knowledge do not seem to constitute scientific progress because they do not enable or provide even simple explanations or predictions. They do not seem to satisfy our curiosity about the world, but rather seem quite pointless. Hence, when we attempt to identify scientific progress, the epistemic account tout court cannot convince. We must adopt a criterion which precludes scientifically irrelevant knowledge from constituting scientific progress. The criterion that a piece of knowledge must possess explanatory or predictive power fulfils this desideratum. Therefore, when we attempt to identify scientific progress, we might plausibly adopt the criterion of explanatory or predictive power, as does my hybrid account.

At this point, one might interject why I do not appoint scientific relevance as a criterion of a proposition's being scientific. Granting this criterion would render my hybrid account redundant because the claim of the epistemic account that scientific progress involves the accumula-

tion of scientific knowledge would already entail that the knowledge in question must be scientifically relevant. However, we have good reason to resist appointing scientific relevance as a criterion of a proposition's being scientific: if we grant this criterion, certain propositions fall into neither the category of scientific propositions nor into the category of non-scientific propositions. Again, consider statistical correlations sans causation. Assuming that scientific relevance is a criterion of a proposition's being scientific, such correlations are not scientific propositions because they are scientifically irrelevant. However, given that such correlations were established by accredited scientific methods, they cannot plausibly be classified as non-scientific propositions either. This is non-classifiability is unsatisfying. Therefore, it seems that we should resist appointing scientific relevance as a criterion of a proposition's being scientific. This, in turn, renders the pragmatic desideratum ii) of my hybrid account a necessary condition of scientific progress.

3 The Hybrid Account versus the Semantic Account

In the previous section, I demonstrated how my hybrid account bypasses the objection of overdemandingness against the noetic account as well as the objection of 'underdemandingness' against the epistemic account. It remains unclear, however, why we are to combine explanatory or predictive power with knowledge, instead of mere true belief. Hence, in this section, I attempt to show in what way the previously delineated condition i) that scientific progress involves the accumulation of scientific knowledge renders my hybrid account more plausible than the semantic account, which merely requires true belief.

According to the semantic account, cognitive scientific progress involves the accumulation of truth or verisimilitude (see [17], [19], and [20]). Such theories of scientific progress, however, have several disadvantages. The naïve account, according to which scientific progress involves the accumulation of truth, must refute the deeply ingrained scepticism as to whether truth is attainable (see [1] and [18]). The verisimilitude account, on the other hand, bears ontological and epistemological burdens: it must give an adequate account of the concept of verisimilitude by determining its logical properties and it must demonstrate how we can epistemically access verisimilitude (see [1]). These are very difficult tasks. Lastly, the semantic account demands too little with regard to scientific progress. According to the semantic account, cases in which we accumulate entirely accidentally true beliefs constitute

scientific progress. For example, in the 4th century B.C., Aristarchus of Samos proposed a heliocentric model of the universe. Aristarchus' model, albeit an accurate representation of the world, relied on faulty measurements, was at odds with the sensualistic evidence available at his time, and could not be confirmed through the observation of a stellar parallax until 1838 A.D. It was a true, yet unjustified belief. In this light, it seems doubtful that the acceptance of Aristarchus' heliocentric model at this time would have constituted scientific progress. According to the semantic account, however, such cases must constitute scientific progress because they involve an accumulation of truth or verisimilitude. In order to avoid this counterintuitive implication of the semantic account, when we attempt to identify scientific progress, we must adopt a criterion which precludes accidentally true beliefs from constituting scientific progress. The requirement that scientific progress involves the accumulation of knowledge fulfils this desideratum given that knowledge entails justification[5]. Therefore, when we attempt to identify scientific progress, we might plausibly adopt the criterion of the accumulation of knowledge, as does my hybrid account.

4 Preserving Plausible Implications and Features of the Noetic Account

Finally, I shall discuss how the criterion of explanatorily or predictively powerful knowledge enables us to preserve plausible features and implications of the noetic account, namely that all instances of genuine scientific understanding constitute scientific progress, that we have good reason to favour idealised, elegant, and simple theories, and that, perhaps, understanding is epistemically more valuable than knowledge.

Due to the criterion of knowledge, my hybrid account (and the epistemic account) can account for all instances of scientific understanding as contributions to scientific progress, even such cases in which our understanding does not rely on a (justified) true belief, but rather on the assumed truth of some proposition or some set of axioms from which we can derive explanatorily or predictively powerful theories. According to my hybrid account (and the epistemic account), such cases are framed as hypothetical knowledge: 'If some proposition p is true, then p explains some set of observables O'. Or, similarly: 'If some proposition p is true, then p predicts some set of events E'. As an example, consider Albert Einstein's explanation of Brownian motion in terms of the kinetic theory of heat (see [4]). Einstein did not have the epistemic justification

in order to know that Brownian motion and the kinetic theory of heat did, in fact, obtain. Hence, the explanandum and explanans were not objects of his knowledge. Nonetheless, Einstein succeeded in demonstrating how Brownian motion is explained through the kinetic theory of heat. Intuitively, this achievement constitutes scientific progress. My hybrid account (and the epistemic account) can account for our intuition: Einstein assumed the accuracy of Brownian motion and the kinetic theory of heat and, based on this supposition, demonstrated how Brownian motion is explained in terms of the kinetic theory of heat. He, thus, possessed hypothetical knowledge.

In other instances of hypothetical knowledge, however, only my hybrid account retains plausibility, whereas the epistemic account does not. Consider Nicole d'Oresme's belief that hot goat's blood splits diamonds (see [1], [4]). Suppose Oresme had developed a theory which, if true, explains why hot goat's blood splits diamonds. Like Einstein, Oresme did not have the epistemic justification in order to know whether his theory does, in fact, obtain. Nonetheless, based on the supposition that his theory does obtain, Oreseme would have succeeded in explaining why hot goat's blood splits diamonds. Intuitively, this achievement does not constitute scientific progress. According to the epistemic account, however, if we are willing to grant Einstein scientific progress in his explanation of Brownian motion, Oresme's theory must equally constitute scientific progress because both of these cases are instances of hypothetical knowledge. In contrast to the epistemic account, my hybrid account can account for our intuition that Oresme's achievement does not constitute scientific progress: Oresme's theory was neither explanatorily nor predictively powerful. In order for a theory to possess explanatory power with regard to certain phenomena, these phenomena must be real. There cannot be explanatory power with regard to merely imaginary phenomena because, then, there is nothing to actually explain (even if we might hypothetically explain the imaginary phenomena). Similarly, in order for a theory to possess predictive power, it must enable predictions regarding the occurrence of some real event, whereby these predictions hold true in actuality (as opposed to enabling predictions regarding the occurrence of some imaginary event, whereby these predictions hold true merely hypothetically). Given that we have made no observations that hot goat's blood does, in fact, split diamonds and that we have no reason to expect it will do so prospectively, Oresme's theory is not explanatorily or predictively powerful and, thus, fails to fulfil the pragmatic desideratum ii) of my hybrid account. Therefore, according to my hybrid account,

Oresme's achievement does not constitute scientific progress. I hope to have shown that, whereas the epistemic account fails to give an accurate verdict in the latter example, my hybrid account gives an accurate verdict in both examples. My hybrid account enables us to account for all instances of genuine scientific understanding as contributions to scientific progress by means of the epistemic desideratum i), whilst ruling out instances of hypothetical knowledge without explanatory or predictive power by means of the pragmatic desideratum ii).

Another plausible feature of the noetic account is its ability to account for considerations regarding idealisations which facilitate scientific explanation and prediction, pragmatic virtues, such as the elegance or simplicity of a theory, and the value of understanding as opposed to the value of knowledge. It seems to me that, in virtue of the pragmatic desideratum ii), my hybrid account can make sense of the appeal of idealised, elegant, and simple theories: Idealised, elegant, and simple theories facilitate it for us to grasp their explanatory and predictive power. Moreover, if we adopt an account of the rate of scientific progress according to which the degree of scientific progress hinges upon the degree of explanatory or predictive power, this would parallel the recently popular stance that understanding may have greater epistemic value than knowledge[6].

Conclusion

In this paper, I have set forth a hybrid account of scientific progress, according to which the accumulation of explanatorily or predictively powerful scientific knowledge constitutes scientific progress. My account is motivated by the deficits of the semantic, epistemic, and noetic account. I have not, however, compared my account to any antirealist functionalist-internalist accounts. Furthermore, some open questions remain. For example, given my hybrid account, how precisely can we account for the rate of scientific progress and how might we quantify the degree of explanatory power, predictive power, and understanding? What constitutes scientific stagnation and scientific regress? How does my hybrid account translate into an account of the aim of science? Such enterprises and questions must be tackled in another paper.

Acknowledgements

This article benefitted considerably from discussion with Alexander Bird and the postgraduate students of the Philosophy of Science seminar at King's College London. Moreover, I would like to thank the anonymous reviewers and editors of Kriterion for their helpful suggestions and careful reading.

Notes

1 It is important to note that, whereas the discovery of novel entities has explanatory power and satisfies our curiosity about the world, the observation of familiar entities does not: When we observe an uncharted entity, this seems to demand an explanation and evokes our curiosity. The explanation for our observation is typically provided by accepting the existence of a novel entity. In contrast, when we observe a familiar entity, this does not seem to demand an explanation or to evoke our curiosity. Accepting the existence of a familiar entity at a certain time and location does not explain or even go beyond our observation, but is precisely what our observation consists in. As an example, whereas the observation of the previously unknown dermophis donaldtrumpi in Panama in 2018 constitutes scientific progress, the observation of a brown-throated sloth in Panama in 2018 does not.

2 Here, it is important to note that there is a distinction between approximate and idealised knowledge. Whereas approximate knowledge mathematically approximates reality, idealised knowledge distorts reality by abstracting from certain unpertinent aspects of reality in order to make it more tractable. Whereas mathematically accurate knowledge is typically preferable to mathematically approximate knowledge, it is not clear that the same holds of idealised and non-idealised knowledge. We might be tempted to say that because idealised knowledge reveals important explanatory factors, whereas non-idealised knowledge potentially obscures these factors, idealised knowledge displays greater explanatory power than non-idealised knowledge. This view, however, is not convincing. Whereas it is certainly true that idealised knowledge facilitates our psychological grasping of the explanatory factors, this does not mean that idealised knowledge provides greater explanatory power than non-idealised knowledge.

3 Beyond that, see [3], [8], [9], [11], and [26] for a factive account of understanding.

4 Beyond that, see [6], [13], [14], [21], [22], [24], [25], [27], and [28] for a quasi-factive account of understanding.

5 It is important to note that, whilst justification is necessary for scientific progress, it is not sufficient according to both my hybrid account and the epistemic account. The reason for this lies in the fact that justification is not epistemically valuable in the way that knowledge is: whereas knowledge secures a valuable epistemic outcome, i.e. truth, justification cannot reliably do so (see [2]).

6 For example, see [6], [9], [13], [14], [21], and [22].

Clara Goebel
King's College London
Philosophy Department
Strand
London WC2R 2LS, UK
<clara.goebel@kcl.ac.uk>

References

[1] Bird, Alexander. "What is Scientific Progress?". In: Noûs 41 (2007), pp. 64-89.

[2] Bird, Alexander. "Scientific Progress as Accumulation of Knowledge: A Reply to Rowbottom". In: Studies in History and Philosophy of Science Part A 39 (2008), pp. 279-281.

[3] Brogaard, Berit. "Anti-realism, Theism, and the Conditional Fallacy*". In: Noûs 39 (2005), pp. 123-139.

[4] Dellsén, Finnur. "Scientific Progress: Knowledge Versus Understanding". In: Studies in History and Philosophy of Science 56 (2016), pp. 72-83.

[5] Dellsén, Finnur. "Scientific Progress: Four Accounts". In: Philosophy Compass 13 (2018), pp. 1-10.

[6] Elgin, Catherine. "Understanding and the Facts". In: Philosophical Studies 132 (2007), pp. 33-42.

[7] Foster, Marguerite & Martin, Michael. Probability, Confirmation, and Simplicity : Readings in the Philosophy of Inductive Logic. New York: Odyssey Press, 1966.

[8] Grimm, Stephen. "Is Understanding A Species Of Knowledge?" In: The British Journal for the Philosophy of Science 57 (2006), pp. 515-535.

[9] Grimm, Stephen. "Understanding". In: The Routledge Companion to Epistemology. Ed. by Duncan Pritchard & Sven Berneker. 2011, pp. 84-94.

[10] Kitcher, Philip. "Explanatory Unification and the Causal Structure of the World". In: Scientific Explanation. Ed. by Philip Kitcher & Wesley Salmon. 1989, pp. 410-505.

[11] Kitcher, Philip. "Scientific Knowledge". In: The Oxford Handbook of Epistemology. Ed. by Paul Moser. 2002, pp. 385-408.

[12] Kuhn, Thomas. The Structure of Scientific Revolutions (2nd ed.). Chicago: University of Chicago Press, 1970.

[13] Kvanvig, Jonathan. The Value of Knowledge and the Pursuit of Understanding. Cambridge: Cambridge University Press, 2003.

[14] Kvanvig, Jonathan. "The Value of Understanding". In: Epistemic Value. Ed. by Adrian Haddock & Alan Millar & Duncan Pritchard. 2009, pp. 95-112.

[15] Lakatos, Imre. "Science and Pseudoscience". In: Conceptus 8 (1974), pp. 5-9.

[16] Laudan, Larry. "A Confutation of Convergent Realism". In: Philosophy of Science 48 (1981), pp. 19-49.

[17] Niiniluoto, Ilkka. "Scientific Progress". In: Synthese 45 (1980), pp. 427-462.

[18] Niiniluoto, Ilkka. "Verisimilitude: The Third Period". In: The British Journal for the Philosophy of Science 49 (1998), pp. 1-29.

[19] Niiniluoto, Ilkka. "Scientific Progress as Increasing Verisimilitude". In: Studies in History and Philosophy of Science Part A 46 (2014), pp. 73-77.

[20] Popper, Karl. Conjectures and Refutations: The Growth of Scientific Knowledge. New York: Routledge, 1963.

[21] Pritchard, Duncan. "Knowledge, Understanding and Epistemic Value". In: Royal Institute of Philosophy Supplement 64 (2009), pp. 19-43.

[22] Pritchard, Duncan. The Nature and Value of Knowledge : Three Investigations. Oxford: Oxford University Press, 2010.

[23] Reisch, George. "Pluralism, Logical Empiricism, and the Problem of Pseudoscience". In: Philosophy of Science 65 (1998), pp. 333-348.

[24] Riggs, Wayne. "Understanding, Virtue, and the Virtue of Understanding". In: Intellectual Virtue : Persepectives From Ethics and Epistemology. Ed. by Michael DePaul & Linda Zagzebski. 2003, pp. 203-227.

[25] Riggs, Wayne. "Understanding, Knowledge, and the Meno Requirement". In: Epistemic Value. Ed. by Adrian Haddock & Alan Millar & Duncan Pritchard. 2009, pp. 331-338.

[26] Sliwa, Paulina. "IV – Understanding and Knowing". In: Proceedings of the Aristotelian Society 115 (2015), pp. 57-74.

[27] Strevens, Michael. "No Understanding Without Explanation". In: Studies in History and Philosophy of Science Part A 44 (2013), pp. 510-515.

[28] Zagzebski, Linda. "Recovering Understanding". In: Knowledge, Truth, and Duty: Essays on Epistemic Justification, Responsibility, and Virtue. Ed by Matthias Steup. 2001, pp. 235-252.