

# What is the value of historically inaccurate reconstructions for the philosophy of science?

## Some reflections on understanding, exemplifying and reinforcing

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**ABSTRACT:** Here I propose that even if, as part of the philosophical labor, philosophically biased and historically inaccurate historical reconstructions are provided and used, philosophers can still benefit from them in a non-trivial way. In particular, I argue that historical reconstructions, even if philosophically biased, can play another equally important role: to enhance our understanding of philosophical theses about science by clarifying some of their concepts or applications.

### 1. Introduction

Among philosophers of science, it has been commonly assumed that history of science should provide the evidence for generating, supporting and falsifying philosophical theses (Popper 1934; Kuhn 1970; Lakatos 1970; Laudan, 1977; Nickles, 1986, 1995). In addition, in order to objectively provide such evidence, historical data is expected to be obtained independently from the preferred philosophical view (Pitt, 2001; Schickore, 2011; Kinzel, 2015); if not, the resulting reconstructions of the analyzed historical episode would be *philosophically biased* and thus, methodologically problematic. For a long time, philosophers of science considered that by being aware of this, philosophically biased reconstructions were customarily avoided, and historically informed the philosophy of science was safely made.

Nonetheless, it has been recently pointed out that, quite often, when doing philosophy of science, philosophers have severely misused historical evidence, making their theses more philosophically biased than historically informed (Schickore, 2011). If this were to be the case, historical reconstructions that are biasedly used and made by philosophers would be of no real philosophical use. The combination of these facts leaves us with the impression that the history of science might have shown the limits of the philosophical endeavor when studying the scientific activity.

The main concern of this paper is methodological: to address the question of *what could be the value of historically inaccurate reconstructions, when philosophically biased, for the philosophy of science?*<sup>1 2</sup>

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<sup>1</sup> By *historically inaccurate reconstructions* I understand seriously defective (incomplete, conflicting, contradictory) reconstructions of scientific episodes, which are defective regarding historical accuracy. By *philosophically biased reconstructions* I understand reconstructions that were made (mainly) to fit a particular philosophical thesis, even if important relevant information had been left aside to serve this purpose.

<sup>2</sup> While a related interesting question could be if there is anything valuable for the history of science in historically inaccurate reconstructions, here I will focus only on the benefits that this type of reconstructions

As a response to such a question, two main answers have been provided. On the one hand, in [Currie & Walsh, forthcoming] it has been argued that, due to their nature, historical explanations (either from history or philosophy) always require to have “‘principles of selection’ that guide in identifying the relevant and irrelevant aspects of the target episode: they tell us what to foreground and what to background (...) and provide contrasts and comparisons, that is, guidance as to which parts of the explanatory text to include and which to exclude” (forthcoming: 10-11). This considered, what could be initially, and mistakenly, regarded as ‘philosophically biased’, might be an important result of a (responsible) use of historiographical methodologies. Meaning that historically incomplete reconstructions could enable clearer historical explanations of episodes from the history of science.

On the other hand, the second answer to the question, first presented in [Martínez-Ordaz & Estrada-González, 2018], says that historically inaccurate reconstructions, when inaccurate due to a philosophical bias, can play a highly important epistemic role for the development of philosophy of science, namely, to enhance our understanding of philosophical theses about science. In this paper, I aim at explaining how such an understanding is valuable and achievable.

In order to do so, I defend that philosophically biased historical reconstructions can be seen as exemplars of the philosophical theses that they were 'designed' to support. In addition, I defend that, as exemplars, this type of reconstructions can promote philosophical understanding of the theses that they were designed to back up. Finally, I sustain that, for many cases, the value of historically inaccurate reconstructions could be epistemic, namely to provide an understanding of our philosophical theses.

The plan for the paper is the following: In Sec. 2, I present the *Dilemma of Case Studies* and an exemplar of it. Sec. 3 is devoted to introduce one of the most effective responses to such dilemma and to argue that this response is not strong enough for ruling out the danger that philosophically biased historical reconstructions pose against the philosophical endeavor itself. In Sec. 4, I explain how exemplification can, under certain conditions, provide understanding, which is a valuable epistemic achievement. In Sec. 5, I defend that philosophically biased reconstructions could greatly benefit philosophy of science by enhancing philosophical understanding; in order to do so, I refer to the literature on scientific understanding and explain how these reconstructions, if taken as exemplars of philosophical theses, could be of important philosophical use. Finally, Sec. 6, is devoted to making some final remarks.<sup>3</sup>

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can offer to philosophy of science. I remain agnostic about the implications that my response could have for other debates from historiography of science about the use of philosophically biased reconstructions.

<sup>3</sup> For simplicity, here I focus only on the philosophical difficulties that *philosophically biased reconstructions* pose against (historically informed) philosophy of science. However, I am aware of the fact that much of what is argued in this paper might be potentially relevant to debates regarding both the philosophical use of case studies and the philosophy of general history, having implications for questions of objectivity and empirical adequacy of philosophical reconstructions.

## 2. Historical evidence and philosophical theses: Some problems

In this section, I present one of the most important challenges that historically informed the philosophy of science faces; namely, the *Dilemma of Case Studies* and I introduce an exemplar of it. Sec. 2.1 is devoted to introducing some basic terminology from the debate on the possibility of identifying historical (in) accurate case studies in the philosophical literature about science. In Sec. 2.2, I present the *Dilemma of Case studies* and in Sec. 2.3, I provide an exemplar of such a dilemma.

### 2.1. Preliminaries

As the majority of philosophers have realized, since the very beginning, historical evidence is of prominent importance when doing philosophy of science. While there could be many different ways of 'cutting' and analyzing history in order to evaluate the construction and the scope of philosophical theses, there is a particular methodology that has proved to be extremely handy for the development of the philosophical study of science: the use of *case studies*. "By examining historical episodes in view of specific conceptual questions, case studies provide the essential link between the history and the philosophy of science"(Pietsch, 2016: 49).

Philosophers tend to agree on the following being the most important tasks that case studies fulfill in the philosophy of science:

- (i) Case studies examine an episode in considerable detail and take into account the context in which it happened. Often, the examined phenomenon and its context are not clearly separable from each other.
- (ii) Relatedly, case studies take into account a large number of variables, while focusing on a single or at most a small number of instances.
- (iii) Often, the phenomenon of interest is examined from a variety of perspectives and with a variety of methods resulting in a heterogeneous data structure.
- (iv) Importantly, case studies are always case studies for something –answering the question 'what is this a case of?', i.e., this is, they relate the examined episode to a certain theoretical concept or a type of phenomenon. (Pietsch, 2016: 51)

Now, historical case studies are not mere sets of information chronologically ordered, they are data that is considered, either by historians or by historically minded philosophers, to be relevant for the explanation of particular episodes. When used to explain historical episodes, such data has to satisfy both a sort of historiographical relevance as well as explanatory relevance –meaning that all the selected information should be sufficient for providing accurate *historical explanations* of a particular phenomenon.

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In addition, while I regard as extremely interesting questions about the nature of case studies (in particular, if philosophical or historical case studies are essentially different from other types of case studies) and of the history of science (in particular, if history of science is of a different nature than history of any other subject), I consider the main proposal that I present here to be neutral with respect to such questions, and so, I do not address any of those problematics here.

Historical explanations are explanations of why one event took place the way it did as opposed to another way.

Crucial to Hull's (1975, 1989) account of historical explanation is the idea that different features carry the 'explanatory load' across different explanations; what generates an explanation's value is sensitive to context. On his view, for some explanations (covering-law explanations most obviously), regularities do explanatory work by drawing together the explanandum with other events and showing why the event was expected. For historical explanations, by contrast, the explanatory load is carried by 'central subjects': "The role of a central subject is to form the main strand around which the historical narrative is woven" (Hull 1989, 255). (Currie & Walsh, forthcoming: 5)

Considering the above, it becomes clear that there would be nothing methodologically wrong if the same historical episode can be explained in many different ways. On the one hand, as historical episodes extremely complex, there is nothing wrong in selecting different approaches to understand and explain different components of the same event. Call these approaches, *frameworks*

So, what is a framework? Frameworks are ways of dividing up and unifying various historical episodes—they are recipes for shifting from chronologies to histories. They have, then, a functional role in historical inquiry: backgrounding and foregrounding. Different frameworks foreground and background different aspects of a historical episode (Currie & Walsh, forthcoming: 7).

So, different frameworks can allow for different reconstructions of the same episode without meaning that only one of them is correct and the rest are false.<sup>4</sup> Nonetheless, an important question to this framework-approach is *can (some) frameworks be damaging to either the historical record or the historically informed philosophy of science?* In what follows I present an argument that motivates an extreme type of caution when doing historically informed the philosophy of science, namely, the *Dilemma of Case Studies*.

## 2.1. The Dilemma of Case Studies

For decades, much attention has been paid to the uses of historical data for philosophical purposes. In the philosophy of science, two important standpoints have been introduced: on the one hand, there are the ones that claim that philosophy of science benefits substantially from the study of historical data. In particular, they defend that philosophical theses could—to some extent—be tested against the history of science. Call these philosophers *HP-optimists*. On the other hand, some have denied that the relationship between history and philosophy of science is neat and informative, call them *HP-skeptics*.

At first, *HP-optimists* argued that any philosophical approach to science had to be entwined with our finest historical knowledge about science (Cf. Hanson 1961, Kuhn 1962, Laudan 1977, Lakatos 1978). In particular, they expected history to provide independent evidence

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<sup>4</sup> I say more about this in Sec. 2.3.

for philosophical claims such that, in some cases, could even adjudicate between conflicting philosophical views (Kinzel 2015: 53). However, it did not take long for *HP-skeptics* to protest against such expectations. They contended that to reconcile history and philosophy of science is most of the time a hopeless task: either philosophers end up finding themselves unable to obtain legitimate philosophical information from particular historical data, or historical data is tampered to fit a philosophical point.

Now, even though there is common agreement on the fact that philosophy of science has systematically proceeded by appealing to the use of case studies, not everybody considers them to be *good enough* methodological tools. As a matter of fact, one of the most powerful arguments in favor of *HP-skeptics* problematizes the case study methodology by arguing that Pietsch's (iv) criterion has played, for the use of historical evidence, a very harmful role. Namely, if philosophers assume that a particular case study is a case study *for something specific*, it is very likely that they overlook, dismiss or neglect important historical evidence that conflict with the specific philosophical goal that they have previously set. The argument goes as follows:

1. **Requirement of Independence:** Philosophical claims and historical evidence are produced independently of each other, and for that reason, the *HP-optimists* expect historical data to provide philosophical claims with independent evidence (Kinzel, 2015: 48, 49).
2. **Reconstructive nature of historical evidence:** Historical evidence is provided by the reconstruction of a particular scientific episode constitutes an attempt to provide a rational understanding of a specific historical moment. Historical reconstructions are not only historical data, but also a particular way to put such data together. In the philosophy of science, historical reconstructions are often used as case studies.
3. **Roles of case studies:** There are at least three important roles that historical case studies could play in the philosophical analyses of science:
  - a. Guidance: The analysis of various historical case studies should guide the philosopher to identify or modify her philosophical stands (Pitt, 2001).
  - b. Confirmation: Historical case studies could confirm a philosophical view "in the sense of raising its credibility and probability, (this) is usually considered the central evidential function of case studies in the philosophy of science." (Kinzel, 2015: 53).
  - c. Adjudication: Historical case studies could be used "to confirm one philosophical doctrine while falsifying a rival position" (Idem).
4. **Predicament of generalization:** When a philosopher of science starts with analyzing a particular case study, it is not clear what should be taken of it—for it is unreasonable to generalize from one case or even two or three (Pitt, 2001: 373). So, the satisfaction of guidance is doomed.

5. **Tampering and cherry-picking:** When a particular case study is selected because it exemplifies a particular philosophical point, it is not clear that the historical data has not been manipulated to fit the point (Pitt, 2001: 373); and if that is the case, the case study might not provide any independent evidence to the philosophical view. In a related vein, the selection of cases might be biased to support the point. Thus, the possibility of either confirmation or adjudication is undermined.

**(C) Therefore,** “even very good case studies do no philosophical work ... They are at best heuristics. At worst, they give the false impression that history is on our side, sort of the history and philosophy of science version of Manifest Destiny... it is not clear what philosophical work is being done” (Pitt, 2001: 373).

Call this the *Dilemma of Case Studies* (henceforth DCS).

### 2.3. A case study of the Dilemma of Case Studies

The threat that the DCS poses against the philosophical activity is the following: across time, philosophers have produced a large number of historically inaccurate reconstructions that seem to have been created to expressively support their particular philosophical theses, call these *philosophically biased historical reconstructions*. This has suggested that philosophers cannot legitimately produce nor support general philosophical claims guided by the history of science; and thus, it is not clear that, at least, the more general philosophical insights can tell us anything significant about the scientific activity.

As DCS seems extremely dangerous for the philosophical endeavor, at least as we know it, the initial worry should be if it is possible to identify instances of DCS in the philosophical practice. In what follows, I will motivate the intuition of DCS being a legitimate threat for the philosophy of science.

First, some conceptual clarifications: *Principle of Explosion* is one of the most characteristic principles of classical logic (and of any other explosive logic), it says that any (explosive) theory will trivialize if it contains at least one contradiction. A *contradiction* is a pair of propositions, where one is the negation of the other - sometimes contradiction is defined as the conjunction of both propositions. A theory is *trivial* if it is possible to derive any proposition from it. Therefore, any inconsistent (explosive) theory will be trivial. That considered, *inconsistency toleration* is practiced when it is possible to recognize sensible reasoning from inconsistent information, this is when explosion has been avoided despite the presence of a contradiction (Carnielli & Coniglio, 2016; Šešelja, 2017).

Since Berkeley reported so in *The Analyst* in 1734, the (Newtonian) Early Calculus has been thought to have operated on an inconsistent basis. According to Berkeley, Newtonian mathematicians, when using the calculus at different points in the calculation of a derivative, they assumed infinitesimals were both zero and non-zero. If this were to be true, the mathematical theory should have rendered to triviality –or discovered to be non-explosive, and thus, *non-classical*. But the theory is well known to be a formal theory of classical mathematics (thus, very likely to be an explosive formal theory). In addition, arbitrary conclusions were not drawn (so, it indicated that logical triviality was not

reached). In light of the above, philosophers and mathematicians have tried to explain how this was even possible.

The first reconstruction of such historical phenomenon was presented by Berkeley (1743), who claimed that, in his *Principia* (1687), Newton characterized infinitesimals inconsistently. Newtonian infinitesimals were –according to Berkeley- entities that behave inconsistently: at some points in a particular proof, they were equal to 0 and, at some other points, they were different than 0. The case study was initially introduced by Berkeley (in *The Analyst* (1734)) as a case of problematical inconsistent mathematics; in order to support his claim, Berkeley appealed, solely, to what could be seen as Newton’s theory of fluxions. From this, it looks like Berkeley considered that a satisfactory study of Newtonian infinitesimals needed only to offer an analysis of the mathematical theory.

Later on, the same historical episode was used by Brown and Priest (2004) to illustrate a ‘safe’ case of inconsistent mathematics and a motivation for paraconsistency in formal sciences. In their reconstruction, they emphasize that the “fact that arbitrary conclusions were not drawn, even though reasoning was carried out on the basis of inconsistencies, means that the inference procedure involved must have been *paraconsistent* (where contradictions do not entail everything)” (Brown & Priest, 2004: 379. My emphasis). Making this into a case of paraconsistent reasoning and satisfactory inconsistency toleration. An interesting remark is that, Brown and Priest did not pay much attention to Berkeley’s original claim nor to the evidence that Berkeley provided for his accusation, in contrast, they neglected the Newtonian theory of fluxions and allowed their reconstruction to be informed by Boyer’s (1959) and Cajori’s (1991) own philosophical reconstructions of the conceptual development of the calculus and the associated mathematical practices (regardless if such practices coincided exhaustively with what the formal theory said).

In addition, years later, the same historical episode was discussed by Vickers (2013) as a case of consistent mathematics with the use of idealizations and different degrees of epistemic commitments. Vickers argued that Berkeley and Brown & Priest, among others, disregarded the fact that “Newton says, exposition in terms of indivisibles or infinitesimals is simply a convenient shorthand (but not a substitute) for rigorous mathematical proof in terms of ultimate ratios (limits)” (Edwards, 1979: 226). Vickers explains that this shows that, for this case, “one can actually keep all of the propositions, and continue to reason with classical logic, and still trust many or most of one’s inferences” (Vickers, 2013: 241). Vickers’ reconstruction pays separated attention to Newtonian’s formal theory (the algorithm) and to the epistemic justification (if any) that mathematicians, especially Newton, had for using infinitesimals as if they behaved inconsistently –it is important to notice that this is a methodological distinction that was not present in Berkeley (1734) nor in Brown & Priest (2004).

In order to carry out such an analysis, Vickers focuses on discussing Berkeley’s original criticism, as well as the *Principia* (1687) and *De Quadratura* (1704), and he informs this with the view of Kitcher (1973) and Guicciardini (1989) regarding Newton’s philosophical commitments. By having looked at some of the philosophical insights of Newton, Vickers argues that the alleged inconsistent use of infinitesimals was just a shortcut and that the real mathematical and philosophical justification indicated that infinitesimals were not to

be inconsistent at all. Given so, Vickers concludes that the way in which logical explosion was avoided in this case was not related to the forms in which information was *chunked*, but to the way in which infinitesimals were regarded as mathematical idealizations.

Finally, the episode was addressed by Sweeney (2014) as a case of inconsistent mathematics without (the need of) idealizations. Sweeney's argument relies on the fact that, even if Newton's explanations were accurate (the ones used by Vickers to justify his thesis), there was a mathematical practice grounded in an inconsistency –with, apparently, high methodological value– which had to be explained in terms of inferential maneuvers for managing the inconsistent information. In order to argue in favor of this, Sweeney brings to the discussion other works of Newton's (1745, 1964) as well as De L'Hospital's *The Method of Fluxions Both Direct and Inverse* (1730).

The diversity of philosophical theses related to this particular case is not in itself methodologically challenging. Actually, there is a common agreement on the fact that as (historical) events are naturally extremely complex, it is nothing but methodologically acceptable to adopt different methodological (and philosophical) points of view in order to obtain a more detailed picture of the general episode. This is, history of science is often done “by developing a more or less explicit tool kit of frameworks, that is, a set of approaches that, judiciously applied, aid the historian and philosopher in navigating the complex, contingent episodes that concern them” (Currie & Walsh, forthcoming: 16). That considered, it would not be anomalous to have different reconstructions of the same episode if they shed light on different aspects of the historical event, especially if they are, in the long run, susceptible to be explanatorily complementary to one another.

However, for the case of the many reconstructions of Newtonian infinitesimals, it is not so clear that the diversity of reconstructions is of the sort just described above. As a matter of fact, it seems that, at least, some of these reconstructions are rivals<sup>56</sup>, making it impossible to consider them to be mutually complementary. For this case, each of the different reconstructions that I have listed above aims at addressing the phenomenon of (*inferential inconsistency toleration*)<sup>7</sup> in Newtonian mathematical practice (paying special attention to the work of Newton), and proponents of each of them assume to have selected all the relevant historical information that is needed for satisfactorily explaining such a phenomenon. Nonetheless, in this case, the set of “relevant” information varies from reconstruction to reconstruction, making each of them neglect elements from the history of science that some of the others consider indispensable.

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<sup>5</sup> I consider that “there is rivalry between two reconstructions if: (a) they emphasize different elements while aiming to recuperate the same historical episode, (b) they seem to not be mutually compatible and (c) it is expected to choose no more than one of them as the correct one for describing such historical episode” (Martínez-Ordaz & Estrada-González, 2018: footnote 3).

<sup>6</sup> The reader might infer from this that philosophical rivalry (in the sense that is defined in the previous footnote) is enough to prove historically inaccuracy of at least one of the parties of the philosophical divergence. However, while this could be, in some cases, a reliable indicator of historically inaccuracy, rivalry is not a necessary condition for the identification of this type of defect.

<sup>7</sup> This is, whether Newtonian mathematicians (in particular, Newton), were able to avoid logical explosion if using (inconsistent) infinitesimals in their practice.

For instance, while Vickers makes a distinction between the formal theory and the epistemic justification, in order to pay special attention to Newton's possible doxastic commitments expressed through his (more) philosophical reflections; Brown & Priest neglect this type of Newtonians commitments as they consider that to show avoidance of logical triviality, solely requires to describe the way in which information could have been managed in the practices associated to the use of the Calculus. This gives the impression that at least one of the many historical reconstructions is overlooking relevant historical information, and thus, at least one of them is *historically inaccurate*.

According to the fifth premise of the DCS, the fact that each of these reconstructions neglects relevant historical facts might be caused by philosophers trying to make historical evidence to fit a philosophical point. In addition, if one confronts all these reconstructions against each other, one will get the impression that the ones that neglect more relevant historical evidence than others might be less historically accurate than their rivals.

The relation between the production, presence, and use of historically inaccurate reconstructions and the fatalistic consequences of the DCS is quite neat. If one cannot get rid of historically imprecise (or even mistaken) reconstructions, it is not clear how philosophers could do genuine analyses of historical facts about science in the near future. And even more problematic, if one cannot make rational sense of such production and use across the past philosophical practices, it is not clear how this will not fatally affect the grounds of our current philosophy of science.

Given the above, it seems that philosophers involved in this particular debate could be facing the *Dilemma of Case Studies* when discussing 'historical evidence' in favor of their philosophical theses. Assuming that DCS represents a threat for the philosophical endeavor, in what follows I present a possible exit from the threat that DCS poses against the philosophy of science.

### **3. The exit(s) and the confrontation model**

This section is devoted to introduce some of the most satisfactory solutions to the DCS and to argue that these solutions are not robust enough to explain out the problematic practice of using and producing philosophically biased historical reconstructions.

Because of the severity of DCS, to answer to the dilemma has become an issue of high importance for philosophers of science. So far, three main types of responses have been provided:

- **(A):** First, some have concluded that the combination of the philosophy and history of science is mostly historically and philosophically uninformative (Schickore 2011, Pitt 2001). These approaches are mostly motivated by the preservation and enhancement of the historical activity for the understanding of science, and they usually weaken the importance and the scope of the philosophical input about science.
- **(B):** Second, others have argued that the relation between both disciplines could still be beneficial—at least for the philosophical party—if philosophers start holding more modest expectations about the philosophical use of historical evidence

(Burian 2001, Kinzel 2015). In contrast with the supporters of (A), supporters of (B) tend to be more optimistic about the philosophical activity, especially regarding the particular type of understanding that philosophy can provide about science, nonetheless the scope of philosophical explanations, according to (B), is still narrow.

- **(C):** Third, in [Currie & Walsh, forthcoming] it has been argued that historiography of science is in general methodologically theory-laden and that this is not problematic in itself. As a matter of fact, the use of such theory-ladenness is what makes possible to provide historical explanations (in the sense they were characterized in Sec. 2.1) of specific and fine-grained aspects of the scientific practice. Methodological theory-ladenness, under the shape of *frameworks* (also in Sec. 2.1), is necessary for any historically informed research.

Even if the (A) and (B) approaches disagree with respect to the benefits of the relation between history and philosophy of science, they share a common enemy: both argue that the DCS is the result of using the so-called *confrontation model*, and thus the avoidance of such model when doing philosophy of science could help philosophers to avoid the DCS (Schickore, 2011; Kinzel, 2015; Scholl, 2018). (C) in contrast, seems to be a way to combine intuitions behind both (A) and (B).

The *confrontation model* consists of a set of assumptions about the scope and the effectiveness of the relationship between history and philosophy of science. The model assumes both “the philosophy of science formulating general claims on the one hand, [and] the history of science providing evidence about particular cases on the other” (Kinzel 2015, 49). In addition, the model also requires philosophical claims and historical evidence being produced independently of each other. The combination of these assumptions has caused philosophers to believe that “past scientific episodes function like empirical data for the construction of scientific theories. They are the starting point for generalizations about science or the basis for tests of general theories of science” (Schickore 2011, 468).

As the reader could have already noticed, the first and third premises of the DCS (‘requirement of independence’ and ‘roles of case studies’, respectively) are partially shared by the confrontation model. So, both the (A) and (B) approaches have to first tackle ‘requirement of independence’ and ‘the role of case studies’.

**Step 1.** To dismiss the first premise of the DCS, (A) and (B) argue that the mere nature of historical evidence prevents us from treating historical information as naïve-empirical data (Schickore 2011). As history is a discipline with diverse methodologies for researching, analyzing and interpreting historical information, all the reports that historians deliver and all the reconstructions that they provide are, in a sense, theory-laden (Kinzel 2015). The problem comes to the table when the methodology that underlies the production of historical reconstruction is (either fully or partially) philosophical, then the criterion of independence is clearly violated. And as historian’s methodological commitments tend to overlap with philosopher’s commitments, while the requirement of independence could be maintained as a regulative ideal, it is clear that it cannot be a strict constraint of good philosophical and historical practice.

**Step 2.** To deal with the third premise of the DCS, philosophers have suggested that for starters, our expectations about integrated history and philosophy of science were mistaken; that, instead of looking for guidance, confirmation and, especially, adjudication, we should be looking for more modest types of evidential support, for instance, recalcitrance and novelty (Kinzel 2015).<sup>8</sup> Such evidential roles that historical data can play are still informative enough for allowing for limited generalizations about the local standards of scientific inquiry (Burian, 2001, pp. 399, 400).

As a result of taking this step, the degree to which a case study ‘confirms’ a philosophical claim thus depends on: (i) the precise formulation of that claim, (ii) how generalist the philosophical aspirations are, (iii) how well the philosophical doctrine in question can deal with local historical variations, and so forth. This means that case studies could still offer empirical support and confirmation to philosophical views, but the exact degree of confirmation depends on the methodological views that are to be assumed by the philosopher.

In contrast, while (A) and (B) seem to be prescriptive about the relation that should hold between history and philosophy of science, (C) has a more explanatory nature, as it explicates why philosophers and historians could not have worked framework-freely and still succeeded at portraying historical events.<sup>9</sup> Actually, to me, it seems that (C) is more comprehensive than (A) and (B) –as it easily explains the success of a research practice that could take place in other philosophical disciplines. However, while (C)’s proposal consists of a pluralism of frameworks, Currie & Walsh are still on agreement with the (A) and (B) standpoints on the fact that there will be reconstructions that will not be acceptable under any conditions, namely the resulting reconstructions of selecting “information from among the set of relevant information in an arbitrary or random way” (Currie and Walsh, forthcoming: 11) or in an extremely philosophically biased manner. Explicitly they claim:

Our discussion demonstrates a way of navigating this apparent impasse. It does not follow from framework ecumenism that *we are allowed to do violence to the past—just as we are not licensed to say whatever we wish philosophically*. Different frameworks, geared toward different purposes, license differing distortions, emphases, and focuses (e.g., Walsh and Currie 2015a). Making

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<sup>8</sup> **Novelty.** One function of historical case studies is that they provide us with new, previously unknown and perhaps surprising information. New information about the precise historical dynamics of an episode of scientific change, new insights into the structure of a scientific debate, new knowledge about the reasons and causes that motivated a certain scientific decision, and so on. Providing us with new knowledge is perhaps the weakest sense in which case studies can be evidential.

**Recalcitrance.** A somewhat stronger claim is that engaging in case study research can force us to revise our beliefs. The hermeneutical process of historical reconstruction described by Schickore is such that initial assumptions are revised and modified in the process of historical reconstruction (Schickore, 2011, p. 472).” (Kinzel 2015, 53).

<sup>9</sup> “Considering that frameworks provide contrasts and comparisons, that is, guidance as to which parts of the explanatory text to include and which to exclude, if a historian is not using a framework, then she must either attempt to provide the ideal explanatory text, that is, cover every aspect of the historical individual, or select information from among the set of relevant information in an arbitrary or random way. Whereas the former is unfeasible, the latter is irresponsible. Doing history requires that careful decisions be made about what to include and what to exclude. Historians must decide how to situate their explanandum in the nexus of the world—which parts of the ideal text to include and which to omit.” (Currie & Walsh, forthcoming: 11)

these explicit, and understanding their different applications, would switch Sorrell's impasse into a potentially productive interchange between these differing frameworks. (Currie & Walsh, forthcoming: 17)

This means that there is nothing wrong with allowing different historiographical and philosophical methodologies to provide different reconstructions of the same scientific episodes, however, what is methodologically malign is to provide reconstructions under a purely intentional philosophically biased ground. The former is a natural way to proceed in historically informed philosophy of science, the latter is easily recognizable as a mistaken way to do any historically informed type research –as in such cases history is brutally silenced in favor of a preferred philosophical standpoint. Nonetheless, I don't think this is the whole story; in the following sections, I explain how this type of extremely biased reconstructions could have an epistemic value for the philosophy of science, despite being so methodologically misconstrued.

In sum, (A)-supporters, (B)-supporters and (C)-supporters have agreed that to take Step 1 and Step 2 could help philosophers to explain how they can make and evaluate bounded general claims about science and why historical evidence can sometimes be theory-laden. This raises the question *can philosophers follow Step 1 and Step 2 and whit it, get rid of the Dilemma of Case Studies?* In what follows, I argue that even if philosophers could stop using the confrontation model, this will only block one of the problems that come with the DCS and will leave the other danger, the one that is the most severe for the philosophy of science, still lingering.

In general terms, the DCS is dangerous for historians of science trying to do philosophy and for philosophers of science trying to support philosophy using historical information. When fighting the DCS, the (A), (B) and (C) alternatives, help historians and philosophers (mostly (C)) to survive such fight. In particular, Step 2 allows moving from historical data to philosophical claims as long as such claims are well- bounded. Nonetheless, it is not clear how either of such solutions will save the practice of providing clearly philosophically biased accounts of historical events. The question that I deal here with, this is, *what is the value of historically inaccurate philosophically biased reconstructions?*

While much more can be said about the DCS, I hope that this suffices for the reader to recognize the importance of this problem. In the following section, I present a vital epistemic goal, namely understanding, which can be achieved through the use of philosophically biased historical reconstructions. In Sec. 5, I explain how philosophically biased historical reconstructions could be of significant use when attaining philosophical understanding of the philosophical and scientific endeavor.

#### **4. Understanding and Selectivity**

In the previous section, I claimed that it was of vital importance to explain why philosophers have employed philosophically biased historical reconstructions for a long time without damaging the discipline to death. To effectively do so, it seems to me that first, it is necessary to say something about the processes that are needed for generating such type of reconstructions, in particular, selection and exemplification.

How are selection and exemplification important for this discussion? Allegedly, philosophically biased historical reconstructions are the result of philosophers first choosing a philosophical thesis, later, identifying the most important components of such thesis, and finally, manipulating the historical evidence in such a way that it exemplifies neatly the previously chosen thesis. In what follows, I assume that philosophically biased historical reconstructions are nothing but intended exemplars of specific philosophical theses, and explore the possibility of exemplars to be vehicles of the epistemic good 'understanding'.

#### **4.1. Understanding and exemplifying**

In recent years, understanding has been meticulously analyzed and characterized as a serious philosophical problem. Many things have been said about the type of intellectual achievement that it constitutes, and many different ways to attain and assess scientific understanding have been proposed (Ammon, 2016; Baumberger and Brun, 2016; Elgin, 1996, 2004, 2009; Wilkenfeld, 2016). In particular, it has been said that the value of understanding seems to surpass that of knowledge, concretely, that

[A]chieving understanding seems an additional step forward, and we would not take this step if it did not have some additional value. Furthermore, knowledge may easily be acquired through the testimony of experts; understanding, by contrast, seems more demanding and requires that an epistemic agent herself puts together several pieces of information, grasps connections, can reason about causes, and this too suggests an added value. (Baumberger, Beisbart and Brun, 2017: 3)

Now, while there is a recent agreement about the philosophical importance of studying the phenomenon of understanding, there is no unanimous view on how to characterize it. For instance, some philosophers have claimed that there are different types of understanding: objectual, propositional, interrogative (Baumberger, 2011; Carter & Gordon, 2014), and explanatory (Baumberger, Beisbart & Brun, 2017); and so, depending on the particularities of the type of understanding that is being studied, different philosophical approaches have been developed. In what follows, I focus exclusively on the approach developed by Elgin (2009, 2017) and on the importance of exemplification for that approach.

First, "an understanding, on this conception, is an epistemic commitment to a comprehensive, systematically connected body of information that is grounded in fact, is duly responsive to evidence, and enables non-trivial inference, argument and perhaps action pertaining to the phenomena the information is about" (Elgin, 2017: 82). In addition, for Elgin, exemplification fulfills (at least) two important roles when talking about understanding. The first one is enabling the generation and the strengthening of a variety of epistemically valuable connections across different domains (Idem 78) and thus, enhancing the interpreter's understanding of specific phenomena. The second one consists in indicating that understanding has been achieved: the capability of providing an example "displays an understanding of the subject. It is not just an instance, it is a telling instance" (Elgin 2017, 77). But why, from an Elgin-type of view, exemplifying is strongly linked to understanding? In order to answer this question, it is important to explain what type of activity is to provide an example.

Given that exemplification is a selective activity:

When an item serves as a sample or example, it exemplifies: it functions as a symbol that makes reference to some of the properties, patterns, or relations it instantiates (Goodman 1968, Elgin 1996). Let us call anything that exemplifies an *exemplar*, and all of an item's properties, as well as all of the patterns and relations it figures in its features. (...) A property then is just that which members of an extension share. Patterns and relations receive analogously tolerant treatment. Thus exemplified features may be dynamic or static, monadic or relational, and may be at any level of generality or abstraction. (...) Because exemplification requires instantiation, only something that actually possesses a property can exemplify that property (Elgin, 2017: 76).

Thus, exemplification is selective in the sense that it requires the identification of particular features of the object/phenomenon that is being studied and to identify similar features in another, apparently, very different object. It is important to highlight that exemplars often can simultaneously exemplify multiple features. Nevertheless, they cannot exemplify all the features of a particular studied object. From an Elgin-point of view, exemplification —for purposes related to understanding— consists in showing that “a single item can, in the right context, exemplify any and many of its features, enabling the interpreter to forge a variety of epistemically valuable connections across a variety of domains” (ibid, 78).

When trying to understand a phenomenon  $X$  through exemplification it is necessary to select a particular group of features of  $X$  that one believes are highly relevant for explaining  $X$  (and while doing so, one will be explicitly dismissing some features as not relevant or idle for the understanding of  $X$ ). Thus, when exemplifying, a common and basic requirement is to remove *distractors* (or idle features). However, “before we can remove the impurities or other irrelevant factors, we need to engage in some analysis: we need to conceptualize the item in question as made from components — those we seek to exemplify, and those we do well to set aside. The analysis is often straightforward. Our prior understanding of the domain frequently enables us to identify the relevant components” (ibid, 81). In the end, one must be able to identify the same features in the chosen exemplar and argue in favor of the connection between  $X$  and the exemplar.

Finally, an Elgin-type of approach to understanding will suggest that

Once we recognize that (...) exemplars marginalize features that are referentially insignificant, we can exploit this capacity through factor analysis. We can construe the phenomenon of interest as factorable into components, distinguish between relevant and irrelevant ones, then sideline the irrelevant ones. (...) Maybe we need to introduce correction factors to accommodate the simplifying assumptions we made in our exemplars; maybe not. But if we recognize that the representation serves to illuminate the phenomena by exemplifying features it shares with them, and that it makes no commitment to the realism of unexemplified features, we can see how such exemplars embody, advance and convey an understanding of the world (ibid, 91)

The process that is described by Elgin in the above quotation seems to reveal another important connection between exemplification and understanding. Sometimes when

providing an exemplar of a particular phenomenon *X*, we discover that what we considered to be the salient features of *X* are not enough (or not adequate) for recognizing the exemplified phenomenon in the ‘actual’ world and that we need to introduce, accommodate or dismiss particular objects or relations that we initially had chosen as components of our exemplar of *X*. Call this *afterlighting*.

As the reader may have anticipated, afterlighting (as an evaluative process) plays a significant epistemic role for our understanding of a particular phenomenon, it promotes a kind of belief revision and with it, it helps to refine the degrees of understanding that epistemic agents can achieve with respect of particular phenomena. Afterlighting is a process that requires epistemic agents to examine exemplars of a specific object of study, one that sometimes has as output the discovery of new features of the studied phenomenon. Confronting alleged exemplars with the object of study, and facing failure might shed light also on which were the causes of such failure. Finally, I consider afterlighting to be the most important epistemic outcome of exemplification because, in the best scenarios, it helps to narrow the description and to construct the explanation of the object of study –the assembly of explanation not being a direct output of the other results of exemplification.

In sum, exemplification helps us to see how the basic components of a particular phenomenon are combined and put together, and more important it highlights some particularities of the phenomenon in such a way that one is able to provide novel explanations of it. According to Elgin’s approach, exemplification promotes understanding through, at least, three different processes:

**(Recognizing):** Identifying salient features of a particular object of study and generating an exemplar of such object guided only by the features previously selected.

**(Providing):** Presenting an exemplar of a particular object and explaining how the salient features of such an object are present in the provided exemplar.

**(Afterlighting):** Evaluating the soundness of the provided exemplar as well as the relevance of the elements previously identified as salient.

In the following section, I relate this approach to understanding the epistemic outputs of using historical reconstructions in philosophical activity.

## 5. Historical and Philosophical Exemplification

As it has been argued in Sec. 2, a common response to the Dilemma of Case Studies consists of endorsing more modest evidential-support aspirations (Kinzel, 2015). Nonetheless, even the ones who subscribe to this modest view have emphasized that the more historically accurate reconstructions are, the more they will be of use for philosophical purposes. This leaves us with an important question: *Can philosophers of science benefit (in a significant way) from philosophically biased and historically inaccurate historical reconstructions?*

In this section, I respond positively to such query and I explain how, despite their historiographical faultiness, philosophically biased historical reconstructions can provide

us with understanding. In order to do so, I appeal to the literature on scientific understanding through exemplification presented in Sec. 3, and argue that philosophically biased historical reconstructions can be seen as exemplars of philosophical theses, and thus vehicles of understanding.

### 5.1. Step 1. Philosophically Biased Historical Reconstructions as Toy Examples

Introducing Elgin's proposal on scientific understanding had the intention of elucidating, through her approach, a way in which philosophers of science could benefit from philosophically biased and historical reconstructions. In order to achieve that purpose, this sub-section is devoted to characterizing philosophically biased historical reconstructions as exemplars of philosophical theses.

*Philosophical theses about science*, for simplicity, could be understood as general<sup>10</sup> explanations about the underlying mechanisms of scientific activity. *Historical Reconstructions of particular scientific episodes* are historiographical explanations of how to put certain historical data together, they assume a particular methodology that allows historians to distinguish between idle and relevant information when telling the history of such episode.

*Philosophically Biased Historical Reconstructions* (henceforth PBHRs) are historical reconstructions in which some parts of the 'actual' story have been dismissed in favor of the philosophical assumptions that have been previously (and independently) chosen (Cf. Martínez-Ordaz & Estrada-González, 2018). Thus, the elements present in the reconstruction are not necessarily historiographically relevant but they are remarkably philosophically pertinent. An important remark is that, for a reconstruction to be philosophically biased does not imply (nor forbid) that such reconstruction could be misleading or defective; it only says of the reconstruction that is philosophically theory-laden.<sup>11</sup> Finally, not all historically inaccurate reconstructions are philosophically biased, some of them just ignore historically relevant elements and fail at illustrating any philosophical thesis (for a case of historically inaccurate reconstructions that do not portrait any philosophical thesis, see Martínez-Ordaz & Estrada-González, 2018: 276-278).

From the above, an important question arises: *Are PBHRs mere 'toy examples'?*<sup>12</sup> The response to this question depends on what we label as 'toy examples'. Consider the following (non-exhaustive) list of possible types of toy examples:

**Extra-simplistic toy example:** A toy example of this kind is a model in which a general sentence is satisfied, such a model only concerns the substitution of free variables by singular terms. For instance, given the proposition "All As are Bs", an extra simplistic toy example of such proposition can be constructed by providing a model in which there are two sets of theories A, B such that  $A \subseteq B$ , for instance, one substitution would be *all gravitational theories are physical theories*.

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<sup>10</sup> The generality of such explanations is gradual, while the main quantifier of some philosophical theses could be universal, the quantifiers of some others philosophical theses could be existential, and this does not pose any trouble against the characterization that I propose here.

<sup>11</sup> I thank the reviewer for this pointer.

<sup>12</sup> I am extremely grateful to Cristina Chimisso for asking me to point this out.

While this type of substitutions is often used in (formal) philosophy, it is not the kind most commonly used by philosophers of science when generating PBHRs. So, let's consider another type of toy examples.

**Minimally-contextual toy example:** A toy example of this kind is a model in which a general sentence is satisfied under certain conditions and such conditions are minimally expressed as part of the model. For example, given the proposition "A is preferable to B in context C", a minimally-contextual toy example of such proposition can be constructed by providing a model in which both 'As' and 'Bs' are linked by a preference-type relation and the conditions that warrant such substitution are expressed, for instance, *during the 17th century, mathematicians preferred internal consistency of mathematical theories over procedural simplicity unless they were using the early calculus.*

Even if these toy examples are more frequent in the literature of the philosophy of science, PBHRs are not exclusively of this type. So, let's consider a third kind.

**Distractors-free toy example:** A toy example of this type is a model in which a general sentence is satisfied in a specific context. For these models, such context is extensively expressed but any element of the context that could conflict with the general sentence is removed.

This particular type of toy examples seems to be closer to the standard PBHRs that we find in the literature of the philosophy of science. PBHRs are often presented as large sets of historical information that have been selected to fulfill two main tasks: to illustrate a philosophical thesis and to leave aside any historical bit of information that could *overshadow*<sup>13</sup> the satisfaction of the thesis; and this coincides with the characterization of distractors-free toy examples. With this in mind, one can say that PBHRs are toy examples of, at least, the two latter types.

## 5.2. Step 2. Good Philosophically Biased Historical Reconstructions and Reinforcement

As I have discussed in Sec. 2, the Dilemma of Case Studies puts philosophers in a very difficult position: if philosophers have produced themselves the historical evidence for expressively supporting their philosophical theses, then it would not be clear how history

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<sup>13</sup> This could be understood in at least two senses:

- On the one hand, 'overshadowing' could mean *to distract from the argument*; for example, in the way in which 'interesting' but irrelevant information about the historical case might distract. This, as argued in (Currie & Walsh, forthcoming), might be a natural result of the activity of choosing a particular methodological framework to explain the episode. And, in this sense, there would be nothing methodologically abnormal taking place in such a practice.
- On the other hand, this could mean *to discredit the argument or to undermine the case for the thesis*; in that case, the intuition would be that this constitutes an important methodological defect, as neither the historian nor the historically minded philosopher is allowed to do violence to the past (Currie & Walsh, forthcoming).

In this paper (Sec. 5.2, Sec. 5.3) I explain why even if historically inaccurate reconstructions were to be of the later type, they would still be epistemically useful for the philosophical endeavor.

I thank the reviewer for giving a better phrasing to my ideas on this point.

of science has ever informed philosophy of science in any significant way (Pitt 2001). However, I believe that when discussing the DCS, something important is been overlooked: some philosophically biased historical reconstructions could be epistemically valuable if they promote (either philosophical or scientific) understanding.

Taking into account the nature of PBHRs, it is not difficult to consider that this particular type of reconstructions aims at being exemplars of specific philosophical theses. Nonetheless, as not all toy examples are epistemically useful, and as some exemplars are better than others (Elgin 2017), I believe not all PBHRs can promote understanding to the same degree. In what follows, I focus only on the PBHRs that instantiate satisfactorily all the relevant elements of specific philosophical theses, and that, because of that, work as exemplars of them. Call these reconstructions *Good Philosophically Biased Historical Reconstructions* (henceforth GPBHRs).

GPBHRs can be only *good* with respect to specific philosophical theses. GPBHR X is a PHBR that is good in virtue of both the way in which it instantiates the salient elements of a philosophical thesis X and the way in which it dismisses the relevant distractors (the ones that could overshadow the fulfillment of X). In that sense, GPBHRs work as well-behaved exemplars of philosophical theses. And if Elgin is along the right lines, exemplars actually play a role in achieving understanding, and thus, GPBHRs can enhance our understanding of, at least, our own philosophical theses.

But again, the intuition about how not all exemplars are equally successful demands a way to evaluate and measure the connection between philosophical theses and GPBHRs. In order to provide a way for doing so, let me appeal to a peculiar type of evidential support that was first introduced in (Martínez-Ordaz & Estrada-González, 2018), namely *Historiographical Reinforcement*.

Historiographical Reinforcement consists of an evidential-type of the relation between historical evidence and philosophical theses. In order to evaluate historiographical reinforcement, it is necessary to assume that a given historical reconstruction could be philosophically virtuous with respect to a particular philosophical thesis X if it reinforces X in any of the following grades:

**Strong Reinforcement:** This level of reinforcement is achieved when, given a philosophical thesis (T) and a specific, relevant historical reconstruction (H'), H' provides a rationale for (a significant part of) T.

**Weak Reinforcement:** This level of reinforcement is achieved if, given a philosophical thesis (T) a specific relevant historical reconstruction (H'), H' supports the basic assumptions of T, contributes to a better understanding of T, illustrates mechanisms relevant for the understanding of T, or clarifies some of the concepts of the theory and their applications. (Martínez-Ordaz & Estrada-González, 2018: 267)

In addition, as not all intended exemplars are good exemplars, for the case of historiographical reinforcement a limit negative case is considered: Given a historical reconstruction, it fails at reinforcing a specific philosophical thesis if it satisfies the following criterion,

**No Reinforcement:** The absolute lack of reinforcement occurs when, given a philosophical thesis (T) and a specific, relevant historical reconstruction (H'), H' does not instantiate any elements of T, nor does it contribute to a better understanding of the philosophical thesis in question (*idem*).<sup>14</sup>

Historiographical reinforcement behaves differently than other evidential relations. On the one hand, the higher limit case, strong reinforcement, seems to warrant scientific understanding: there is a philosophical thesis that explains part of the scientific realm and we have found a good exemplar of such explanatory success. So far, it seems that the underlying mechanisms of such understanding are of the type of 'Recognizing' and 'Providing' (as described in Sec. 4.1). On the other hand, weak reinforcement provides an alternative route for philosophical understanding: one intended to introduce an exemplar of a philosophical thesis, but the data was biased and thus, the possibility of providing evidential support has been weakened. Nonetheless, through a mechanism of the type of 'afterlightening' (also described in Sec. 4.1), one can still discover something new about one's philosophical commitments.

### 5.3. Against weak reinforcement

Concerning weak reinforcement, the reader might wonder if, in cases where we risk damaging the historical record, *philosophical 'fictional' case studies* (invented purely to play the role of exemplars to philosophical theses) would not do just as well. This question seems to lead us to a peculiar dilemma: On the one hand, if this is possible, as there would be no need for historical information to fill up the philosophical theses, these theses could be weakly reinforced by purely false information –which seems extremely counterintuitive. On the other hand, if there is a demand for historical accuracy, it is not so clear how the reinforcement-approach to reconstructions does not collapse in the traditional standpoint –the same view that gave rise to the DCS. So far, while I do not consider the use of full-blooded fictions to be equally fruitful than the use of historically informed reconstructions (even if not fully accurate), I believe that even these reconstructions can yield *some* philosophical understanding. Let me press further on this point.

Regarding the first horn of the dilemma and the counterintuitiveness of achieving (philosophical) understanding via falsities. First, it is important to notice that *philosophical fictional case studies*, if satisfactorily linked to specific philosophical theses, they would behave as, at least, extra-simplistic toy examples (characterized in Sec. 5.1). In addition, if the connection between *X* and the exemplar of *X* is exemplificatively-adequate, namely, that the exemplar exhibits the selected properties of *X*, as well as the highlighted patterns and relations it figures in its features (Elgin, 2017: 76), an exemplification of *X* could yield to the understanding of *X*. That said, if the fiction adequately exemplifies (part of) a specific philosophical thesis, it could yield to the understanding of such a thesis.

However, the opponent might still reply that, even if the connection between *X* and its exemplar is what looks more distinctive of this type of approach, it is not clear that a sort of factive condition (a requirement of the exemplar to be 'real') should not be also demanded

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<sup>14</sup> Related notions of reinforcement could be found in: Larry Laudan (1977) and Mohamed Elsamahi (2005).

for gaining understanding via exemplification –especially considering that the satisfaction of this sort of condition is often assumed when endorsing Elgin’s point of view. To respond to this objection, one can argue that, even if the exemplar is fictional, and in a sense, false, this false character of the exemplar does not necessarily block the possibility of achieving understanding via philosophical fictional case studies.

In the corresponding literature, it has been argued that *False Theories can still Yield Genuine Understanding* (de Regt & Gijssbers, 2017). This is, for a given set of propositions, even if the veridicality condition (also called ‘factic condition’) is not satisfied, this would not necessarily prevent philosophers from gaining an understanding of such a set of propositions. According to de Regt & Gijssbers (2017), what is needed for understanding is only the satisfaction of an ‘effectiveness condition’ (where, for this case, ‘effectiveness’ could be understood as the tendency to produce useful philosophical outcomes of certain kinds). So, even if the philosophical fictional case studies were clearly false, if they could still produce relevant philosophical products, they would still be able to lead us to achieve some understanding of the theory they aim at illustrating.

The limitations that could come with gaining understanding via fictions might include that the type of understanding that is gained is, only, *modal understanding*. “One has some modal understanding of some phenomena if and only if one knows how to navigate some of the possibility space associated with the phenomena” (Le Bihan, 2017: 112). In the case of fictions about science, to achieve modal understanding of the philosophical theses that a particular fiction is designed to exemplify, would be to determine the set of possible worlds that correspond to the generic structural features assumed by the philosophical view that such a thesis substantiate (this is, if the thesis were to be true, which type of scientific practices would it describe, how would these practices relate to one another, among others).

All this considered, as a response to the first horn of the dilemma, I think that the solely fictional character of this type of case studies does not prevent philosophers from gaining a philosophical understanding of their theses. However, it seems to me that the falsity involved in full-blooded fictions might block the possibility of achieving an understanding of fragments of the history of science.<sup>15</sup>

Regarding the second horn of the dilemma –about the closeness between the reinforcement-approach and the traditional standpoint. I consider the answer to be

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<sup>15</sup> One might wonder if extreme inaccuracy (or even falsity) isn’t necessarily a problem, and fictional case studies can still lead to understanding, then is there any reason to pay attention to the history at all? I think there is. First of all, I consider philosophy of science to be an investigation about science, and in particular a chase for explanations of scientific phenomena. In light of that, what inaccurate reconstructions provide in the majority of cases is only understanding about our philosophical thesis. But even if one can gain scientific understanding (understanding about science) via the analysis of inaccurate reconstructions, it is still debatable if that will necessarily imply that one gains explanation as well (Elgin, 1996, 2004, 2009; Baumberger, 2011; Carter & Gordon, 2014; Ammon, 2016; Baumberger & Brun, 2016; Baumberger, Beisbart & Brun, 2017). So in that sense, to have historically accurate reconstructions is still very much desirable as they could be of prominent use for achieving explanation.

straight forward: the proposal that I have presented in this paper assumes both the desirability of historical accuracy when providing historical case studies in the philosophy of science, as well as the possibility of historically inaccurate reconstructions to be valuable for the philosophical endeavor. According to the reinforcement-approach, the former corresponds to the pursuit of strong reinforcement of philosophical theses (via historical case studies), and the latter corresponds to the acquisition of weak reinforcement for philosophical theses (in particular, the achievement of philosophical understanding). When historical accuracy is discovered to be implausible to be completely satisfied, the philosopher of science can adopt any of the methodological views sketched in Sec. 3 and be able to explain why the philosophical study of science can still be carried out successfully even if historical accuracy is not fully attainable –in such a way, the DCS weakens dramatically. In addition, the reinforcement-approach would allow philosophers to explain why *some* historically inaccurate reconstructions (when being philosophically biased) can still have an important epistemic value in philosophical research.

The combination of these responses shows that the allegedly troubled scenario consists of a false dilemma and that the approach that I submitted in this paper is a midpoint between the possibility of understanding philosophical theses from a false basis and the strong commitment to historical accuracy when evaluating the use of historical evidence in the philosophical practice. So, while the reinforcement approach is compatible with the traditional view, it is innovatively explanatory of why one can benefit from some traditionally unwelcome type of historical reconstructions.

#### **5.4. Understanding the exemplar**

For the particular case of the Newtonian Early Calculus (first introduced in Sec. 2.3), it is easily to recognize that, so far, no agreement has been reached on the fact of how to accurately portrait such a historical episode (regarding solely to the possibility of inconsistency toleration). This is, it is not clear to philosophers if any of the many reconstructions that I presented could reinforce strongly one of the many philosophical theses involved. However, it is not difficult to see is that all of them reinforced weakly their philosophical theses. To only mention one way in which this has been done, let me refer first to the Brown & Priest (2004) reconstruction.

In [Brown & Priest, 2004], the authors aim at providing a formal mechanism that could do both explain and allow for representing the inferential strategies that human reasoners tend to follow when dealing with inconsistent or conflicting information. This mechanism is named ‘Paraconsistent Reasoning Strategy *Chunk and Permeate*’. One of the benefits of their proposal is that it allows for change-of-logic maneuvers (scientists could change the logic that underlies their reasoning depending on the inferential tasks that they have to fulfill) and that it is not strongly logic-dependent (different logics could be explanatory of the different inferences that scientists do and this is not problematic).

[Brown & Priest, 2004]’s proposal is mostly inspired by the foundations of non-aggregative logics and epistemic fragmentation, nonetheless, as their approach consists of a hybrid formal resource, it is not clear how to go from the formal properties of the strategy to its

application to philosophy of science. What the Newtonian Early Calculus helps to see is the bridge between the formal properties of the Brown & Priest-strategy and the way to select relevant information about scientific reasoning from the historical record.

This, of course, does not mean that they have proved that the reasoning that Newtonian mathematicians followed was anything but paraconsistent. As a matter of fact, according to Vickers (2013), Brown & Priest's reconstruction was historically flawed as well as more driven by a philosophical trend (the attention to paraconsistent logics applied to science) than historically informed:

[T]he simple story we are met with so often in the literature, of the early calculus as a set of inconsistent propositions plus a logic, is plain wrong. Brown and Priest (2004) are typical of a subsection of the philosophy of science that assumes the early calculus can be reconstructed by making use of a paraconsistent logic. To motivate the application of a particular paraconsistent logic they dub 'chunk and permeate' (...) Clearly this blurs the important distinctions between the algorithms of the calculus, the story one tells oneself whilst making a derivation, and the attempted justifications of the moves made within the algorithms (...) However, Brown and Priest are simply following a theme in philosophy of science which is completely entrenched. (Vickers, 2013: 186-90)

In that sense, if Vickers objections are along the right lines, the reconstruction provided by Brown & Priest might be a philosophically biased historical reconstruction (PBHR). Nonetheless, as I had previously argued here, this would not necessarily mean that the reconstruction should be absolutely abandoned. Actually, I think this case illustrates perfectly how one can achieve weak reinforcement to the use of a PBHR. Let me press further on this point.

First, the corresponding literature has shown that, via the analysis of the Newtonian case study presented in [Brown & Priest, 2004], not only authors but readers have grasped a better understanding of what would be to use *Chunk and Permeate* to formalize and explain inconsistency tolerant reasoning in the sciences. The many following applications of the paraconsistent strategy accompanied by reflections on the Newtonian case study support this idea (Sweeney, 2014; Brown & Priest, 2015; Brown, 2016, 2017; Friend & Martinez-Ordaz, 2018). In addition, a proof of the above could be that one of the other reconstructions mentioned in Section 2.3 (Sweeney, 2014) uses the same formal mechanism to explain the same case in an, allegedly, *more* historically accurate way – improving Brown & Priest historiographical methodology but not the philosophical thesis. As a matter of fact, the philosophical thesis might have not changed much since it was presented in 2004, the thing that has varied across related papers is the examples that are provided to illustrate the functioning of *Chunk and Permeate*.

That said, it is possible that the Newtonian historical reconstruction has helped the authors themselves and the readers to understand better Brown & Priest's formal proposal, regardless how much historical understanding of the case they were able to obtain –yet, it also seems that the fact that their reconstruction was not fully fictional, enhanced the more historically informed project later undertaken by Sweeney. All this could be phrased in terms of achieving *weak reinforcement*.

## 6. Final remarks

If the history of science has the main role of either supporting or falsifying philosophical theses, and it is expected that, in order to fulfill such tasks, historical information is used highly accurately when facing philosophical claims. Given so, historically inaccurate reconstructions have to be regarded as pitiful. In addition, everything is even worse if the historical inaccuracy is the result of a clear methodological bias –for the purposes of this paper if historical reconstructions were made (mainly) to fit a particular philosophical thesis, even if important relevant information had been left aside to serve this purpose. The so-called *Dilemma of Case Studies* takes further this worry and says that this particular type of biased reconstructions puts in extreme danger the legitimacy of historically informed philosophy of science. In particular, it says that if philosophers of science had systematically altered the historical record to benefit specific philosophical views, and if the history of philosophy is full of these types of reconstructions, how can we make sense of the constant use of biased reconstructions?

With the above in mind, here I addressed two important questions from the philosophy of science, namely: *Can philosophers of science benefit (in a significant way) from philosophically biased historical reconstructions? And how is that possible?* In order to respond to such questions, I characterized philosophically biased historical reconstructions as trying to exemplify specific philosophical theses.

Later on, in Sec. 4, I appealed to the literature in scientific understanding according to which understanding is achievable via exemplification, and argue that if a certain type of historically inaccurate reconstructions of scientific episodes could be taken as exemplars of philosophical theses, they could enhance our understanding of, at least, such theses. I proposed that exemplification could promote understanding through, at least, three different processes:

**(Recognizing):** Identifying salient features of a particular object of study and generating an exemplar of such object guided only by the features previously selected.

**(Providing):** Presenting an exemplar of a particular object and explaining how the salient features of such an object are present in the provided exemplar.

**(Afterlightning):** Evaluating the soundness of the provided exemplar as well as the relevance of the elements previously identified as salient.

Considering the above, I argued that historical reconstructions, even if not historically accurate, can play another equally important role: to enhance our understanding of philosophical theses about science via exemplification (of specific theses). This is, they could be taken as exemplars of philosophical theses.

Finally, I presented different ways in which the evidential relation between historical data and philosophical theses could be characterized:

**Strong Reinforcement:** achieved when a historical reconstruction provides a rationale for (a significant part of) a philosophical thesis.

**Weak Reinforcement:** achieved when a specific relevant historical reconstruction contributes to a better understanding of a particular philosophical thesis.

**No Reinforcement:** Achieved when given a philosophical thesis and a specific, relevant historical reconstruction, the latter does not instantiate any elements of the former (and thus, does not behave as an exemplar of the thesis).

The benefits of this approach include explaining why *some* philosophically biased historical reconstructions could have an epistemic value for the philosophical endeavor, this is weak to reinforce philosophical theses by enhancing the understanding of such theses.

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