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Metaphysics of Scientific Practice

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Overview: The method of metaphysics of scientific practice consists in developing metaphysical claims on the basis of empirical information from and about scientific practice. This method stands in the tradition of naturalistic or scientific metaphysics, on the one hand, and philosophy of science in practice on the other. In this chapter we draw on some of our own research to specify the method at work. We argue that the method is typically carried out in four steps: identifying the available empirical information that might be relevant to the metaphysical topic of interest; selecting the relevant empirical information; developing a preliminary metaphysical claim that the relevant empirical information supports; and mutually adjusting empirical information and metaphysics. We reveal some major methodological challenges and present ways to overcome them. We conclude that when drawing metaphysical claims from scientific practice we need to: first, make sure that our previous metaphysical views do not influence the empirical information or its selection in problematic ways; second, explain in what sense we are doing metaphysics, countering for instance the idea that metaphysical claims must be highly general and transdisciplinary. We end the chapter by pointing to the advantages of the method of metaphysics of scientific practice.

15.1 Introducing the Method

Metaphysics of scientific practice is a method that brings together a philosophical interest in metaphysical issues with a philosophy of science that pays special attention to the actual practice of science. This method proceeds by developing metaphysical claims on the basis of a thorough analysis of empirical information from and about scientific practice (see Figure 1).

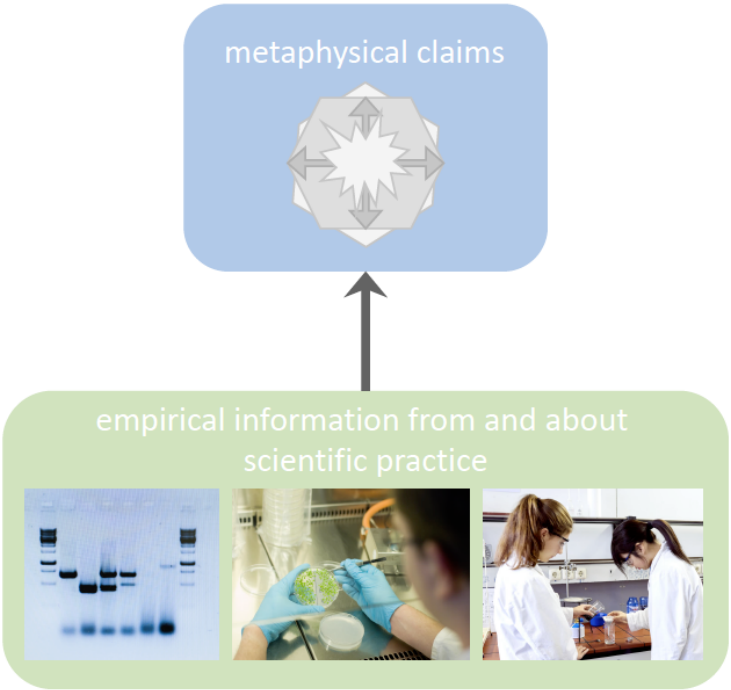

Figure 15.1: The Method of Metaphysics of Scientific Practice: drawing metaphysical claims from empirical information from and about scientific practice. (photos © Bielefeld University)

The empirical information used as source for metaphysical claims can be very diverse. Metaphysicians of scientific practice typically consider the results or products of scientific investigation (e.g., scientific theories or explanations), as well as the scientific activities that leads to these results – that is, the different epistemic practices (e.g., measurement practices, reasoning practices, explanatory practices, individuation practices) that characterize a scientific field. Hence, this method builds metaphysical claims on empirical information *from* scientific practice (results, products) and empirical information *about* scientific practice (activities, practices). This information can be extracted from scientific publications, but it can also be obtained by direct interaction with the scientists in multiple ways (e.g., joint research projects, email exchange, qualitative methods such as interviews). The method of metaphysics of scientific practice is thus very similar to doing philosophy of science in practice (Ankeny & Leonelli, Chapter 17, this volume), with the difference of aiming at metaphysical, not epistemological, claims. Depending on which empirical information is considered and how it is gathered, this method can involve case studies (Currie, Chapter 10, this volume) and make use of qualitative methods (Veigl, Chapter 18, this volume). Drawing metaphysical conclusions from empirical information from and about scientific practice can also incorporate elements of conceptual analysis (Koskinen & Alexandrova, Chapter 5, this volume). Since scientists also raise metaphysical questions and since metaphysical claims can also be scientifically relevant, this method is also applied in philosophy *in* science (Pradeu, Chapter 13, this volume; Laplane et al., 2019; Pradeu et al., forthc.). Even though this method rarely has been made explicit and named in this way (with the exception of Kaiser, 2018a; Kaiser & Trappes, 2023), there are several philosophers of science whose work is in line with our approach and who use the method of metaphysics of scientific practice (or a similar method). Among the examples are: Reydon (2008); Pradeu (2012); Ereshefsky & Reydon (201)5; Waters (2017); Nicholson & Dupré (2018); Guay & Pradeu (2020); Hüttemann (2021); and Triviño (2022).

Our own research exemplifies how the method of metaphysics of scientific practice is used in the philosophy of biology: Kaiser (2018a) addresses the metaphysical question of what makes a molecule a part of the human genome by analyzing the methods that ENCODE (Encyclopedia of DNA Elements) researchers use to individuate genomic parts, how they draw conclusions from empirical data, and how they spell out the aims and importance of their research. Suárez and Stencel (2020) investigate how biologists attribute the status of biological individuals to symbiotic associations between an animal host and its microbiome (i.e., the so-called holobionts). From this empirical information, they draw the metaphysical conclusion that biological individuality is perspectival, and that the attribution of the status of "individual" or "(ecological) community" to a specific holobiont depends on the specific part of the association that biologists are studying.

Typically, the method of metaphysics of scientific practice is applied in four steps: identifying the *available* empirical information that might be relevant to the metaphysical topic of interest; selecting the *relevant* empirical information; developing a preliminary metaphysical claim that the relevant empirical information supports; and mutually adjusting empirical information and metaphysics. In Section 15.3, we will illustrate these four steps in more detail and point to some open questions and methodological challenges. First, in the next Section, we situate metaphysics of scientific practice in relation to inductive and naturalistic metaphysics.

15.2 An Approach Within Inductive Metaphysics

Metaphysics of scientific practice is a specific approach within inductive metaphysics that is characterized by the use of empirical sources and inductive methods to develop metaphysical claims (Engelhard et al., 2021; see also Scholz, 2018; Hüttemann, 2021; Schurz, 2021; Seide, 2021). Inductive metaphysics draws on different empirical sources of knowledge to build its claims, most prominently empirical data and other scientific findings (e.g., well-established scientific hypotheses and theories), but also possibly inner experience or everyday life experience (Engelhard et al., 2021).

Inductive metaphysics is characterized by the use of those methods that have been employed successfully in the empirical sciences, namely inductive methods such as creative abduction (i.e., inferring conclusions from the observed phenomena that contain new theoretical/metaphysical concepts; Schurz, 2021) and inference to the best explanation (IBE). IBE is frequently used in contemporary metaphysics (e.g., Swoyer, 1999; Bird, 2007). Using IBE in metaphysics requires that there is an empirical phenomenon that can be explained by alternative metaphysical claims. IBE then advises us to endorse the metaphysical claim that best explains the empirical phenomenon (see also Scholz, 2018; Hüttemann, 2021). Methodologically, inductive metaphysics practice shares a central assumption with naturalistic or scientific metaphysics (within metaphysics of science; McKenzie, Chapter 14, this volume), namely that science should be our main guide to metaphysics (e.g., Ladyman & Ross, 2007; Maudlin, 2007; Callender, 2011; Ross et al., 2013; Chakravartty, 2013). However, it differs from naturalistic metaphysics in that it does not rule out the use of a priori methods in metaphysics (e.g., appeal to intuitions or transcendental arguments), but rather considers them to be valuable parts of the metaphysician's toolbox (Engelhard et al., 2021). Additionally, it abandons the naturalists' narrow focus on scientific theories (and the even narrower focus on physical theories) and it instead takes into account all available scientific knowledge, of all kinds and from all disciplines, as well as information about various epistemic practices in science (for more details, see Kaiser, 2018a).

Inductive metaphysics relies on a standard view of what metaphysics is: metaphysics explicates the general structure of reality, but not the features of our knowledge or representations of this reality, which is the goal of epistemology (van Inwagen, Sullivan, & Bernstein 2023). Metaphysical claims thus are claims about which kinds of entities exist in the world, their nature, and how they are related to each other. Empirical information is considered a legitimate source for metaphysical knowledge because it helps to ensure that metaphysical claims have reference to the world and are not only concerned with representations and conceptual schemes (Engelhard et al., 2021).[1]

To distinguish metaphysics from particular sciences, it is common to claim that metaphysical claims and concepts must be sufficiently general, because metaphysics is concerned with the "real natures of the world while science is concerned… [with the] instances of these natures" (Paul, 2012, p.5). Some inductive metaphysicians adopt this view and spell out the requirement of generality in terms of transdisciplinarity. They claim that, contrary to theoretical concepts in particular sciences, metaphysical concepts must be aimed at bridging several scientific fields and addressing questions that are not dealt with in only one scientific field (Schurz, 2021; Engelhard et al., 2021). We think that the requirement of transdisciplinarity is too strong and results in a too narrow understanding of inductive metaphysics. There can be metaphysical claims about stemness, the mechanisms of niche choice, conformance and construction (NC^3 mechanisms), hologenomic adaptation, or animal personality, even if these concepts are only used in one scientific field, such as

[1] This is why it is contested to draw metaphysical conclusions from inner or everyday life experience.

biology. It might follow that there is no clear boundary between metaphysics and biology, but, as we argue in Section 15.4.2, this is not problematic.

In other respects, metaphysics of scientific practice is clearly situated within inductive metaphysics. First, it uses empirical sources to develop and justify metaphysical claims; specifically, it builds on empirical information from and about scientific practice as the primary source of knowledge to make metaphysical claims. Second, it adopts the openness of inductive metaphysics, recognizing that, in addition to empirical information from and about scientific practice, there might be other, for instance a priori, sources for developing metaphysical claims. Finally, metaphysics of scientific practice can use inductive methods (in particular, IBE) to develop metaphysical claims. The empirical information from and about scientific practice that is relevant to a specific metaphysical question or topic can be extensive and varied, and often allows for developing multiple metaphysical claims as metaphysical explanations of the empirical phenomenon (i.e., the set of all relevant empirical information). IBE enables us to make a justified choice among the rival metaphysical claims, guiding us to select the one(s) that best explains the scientific practice. We will discuss the methodological challenges of using IBE in metaphysics of scientific practice in Section 15.3.

3. Specifying the Method at Work

In Section 15.1, we mentioned the four steps of applying the method of metaphysics of scientific practice; we now explicate those steps.

Step 1: **Identifying the *available* empirical information.** We normally start with an idea of the metaphysical topic of interest. Based on this topic, we identify the kinds of scientific knowledge and epistemic practices that might be relevant to approaching the topic, and which are accessible to us.

Step 2: **Selecting the *relevant* empirical information**. This step often requires clarifying the metaphysical topic and formulating one or more specific metaphysical questions or problems. We select the empirical information that is relevant to the metaphysical question(s) or problem(s) from the available and potentially relevant empirical information identified in step 1.

Step 3: **Developing preliminary metaphysical claim(s)**. We develop one or more preliminary metaphysical claims that are supported by the relevant empirical information. There are two possible approaches: one draws directly from the empirical information; the other draws connections to the existing metaphysical literature. The claims can be developed either inductively, by relying on the methods of inference to the best explanation, or more deductively, by exploring the logical space of possibilities.

Step 4: **Mutually adjusting empirical information and metaphysics**. This step consists in repeating the first three steps (or at least steps 2 and 3), until we have reached a reflective equilibrium between the metaphysical question, the metaphysical claim(s), and the empirical information (Thagard, 1988; Kaiser, 2019). In interesting cases, this step may allow us to formulate new metaphysical questions and thus extract new unforeseen metaphysical consequences.

Table 15.1 provides some recent examples from our own research where these four steps were used, and it explains further what each step required us to do. In addition to exemplifying the method, these examples highlight the method's diversity and how the researchers have a wide margin to decide what sources they will rely on. The rest of this section digs a bit deeper into the examples to highlight some methodological challenges that we encountered during the process of getting our results.

Paper	Step 1: Identifying available empirical information	Step 2: Selecting relevant empirical information	Step 3: Developing preliminary metaphysical claim(s)	Step 4: Mutual adjustment
Kaiser (2018a)	***METAPHYSICAL TOPIC*** Genomic part-whole relations	***METAPHYSICAL QUESTION*** What criteria determine whether something is a part of the human genome?	***METAPHYSICAL CLAIM*** Something is a genomic part if and only if it engages in a certain kind of biochemical activity tracked by ENCODE's methods.	***METAPHYSICAL CLAIM*** Something is a genomic part if and only if: (a) it has a causal role function, and (b) it is an actual segment of the genome's DNA sequence.
	AVAILABLE EMPIRICAL INFORMATION Publications from the members of the ENCODE consortium and their website (www.encodeproject.org)	***SELECTED EMPIRICAL INFORMATION*** Focus on review and opinion papers; focus on general representation of ENCODE's methods	***METHOD*** Focus on ENCODE's methods, techniques and general strategy	***METHOD*** Broadening the empirical basis, considering also how ENCODE researchers interpret empirical data, discuss findings, specify goals, and place their research in a broader context
Suárez & Stencel (2020)	***METAPHYSICAL TOPIC*** Multispecies biological individuality	***METAPHYSICAL QUESTION*** Are multispecies systems individuals or communities?	***METAPHYSICAL CLAIMS*** Four potential claims: (1) pluralism about individuality; (2) individuality quasi-eliminativism; (3) gradual individuality monism; (4) individuality perspectivism	***METAPHYSICAL CLAIM*** Biological individuality is perspectival.
	AVAILABLE EMPIRICAL INFORMATION Search of keywords in research engines; interaction with scientific groups (email, lab meetings); focus on empirical papers	***SELECTED EMPIRICAL INFORMATION*** Focus on studies that try to conceive multispecies systems as separate entities, rather than holistically	***METHOD*** Exploration of the space of possibilities directly drawn from the empirical evidence	***METHOD*** Identification and revision of the claim that is better supported by the empirical evidence, discarding claims without empirical support
Kaiser & Müller (2021)	***METAPHYSICAL TOPIC*** Animal personality	***METAPHYSICAL QUESTION*** What is the personality trait boldness?*	***METAPHYSICAL CLAIM*** Boldness is expressed in a specific cluster of measured behaviors.*	***METAPHYSICAL CLAIM*** Boldness is the disposition to exhibit risk-taking behavior in situations with an actual or potential threat.*
	AVAILABLE EMPIRICAL INFORMATION Scientist as a coauthor; frequently cited review papers and empirical studies	***SELECTED EMPIRICAL INFORMATION*** Thirty representative empirical studies on boldness (identified by an ISI Web of Science search)	***METHOD*** Generalizing about how boldness is measured	***METHOD*** Introducing the dispositional framework, identifying the manifestation and manifestation conditions
Kaiser & Trappes (2023)	***METAPHYSICAL TOPIC*** Niche conformance, choice and construction (NC^3) and mechanisms	***METAPHYSICAL QUESTION*** Are NC^3 processes or mechanisms?*	***METAPHYSICAL CLAIMS*** Two alternative claims: (1) NC^3 are mechanisms. (2) NC^3 are processes.*	***METAPHYSICAL CLAIM*** NC^3 are mechanisms because they: (a) lead to specific outcomes and (b) reveal how these outcomes are brought about.*

	AVAILABLE EMPIRICAL INFORMATION Joint collaborative research project with biologists; not many publications because projects were still awaiting final results	***SELECTED EMPIRICAL INFORMATION*** Project plans and experimental designs described in the grant application and in talks; reports on empirical results in talks and publications; questionnaire and interviews (from 2018/19)	***METHOD*** Identifying divergent uses of the term 'mechanism'; revealing different views on whether NC^3 are mechanisms or not	***METHOD*** Analyzing the reasons for calling NC^3 mechanisms that biologists mentioned in the questionnaire
Suárez (2023a)	***METAPHYSICAL TOPIC*** Stemness and dispositions	***METAPHYSICAL QUESTION*** Is stemness an extrinsic disposition?	***METAPHYSICAL CLAIM*** Maskers (i.e., objects blocking the manifestation of the disposition) are the source of the extrinsicness in some stem cells.	***METAPHYSICAL CLAIM*** Stemness is sometimes an extrinsically masked disposition.
	AVAILABLE EMPIRICAL INFORMATION Review of textbooks on stemness; search of keywords in research engines; focus on experimental work	***SELECTED EMPIRICAL INFORMATION*** Focus on molecular stem cell studies and exclude those about populations or community properties	***METHOD*** Use of creative abduction; assistance of the existing literature on dispositions	***METHOD*** Reflection on the possibility of formulating a different metaphysical question arising from the metaphysical topic and the available empirical information. Basis for Suárez (2023b)

* These papers address several metaphysical questions and develop several metaphysical claims; for clarity, in this table we present only one question and one (set of) claim(s).

15.3.1 Step 1: Identifying available empirical information

Identifying the available empirical information is guided by the metaphysical topic that we, as philosophers, are interested in. The topic can be derived from philosophical debates (e.g., on biological individuality, dispositions, part-whole relations, mechanisms), from biological research (e.g., on animal personality, stemness, NC^3 mechanisms), or from both. The available empirical information can be of diverse kinds: different sorts of scientific publications; scientific textbooks; grant applications; scientific research talks; direct collaborations with scientists; the results of interviews and questionnaires. All can provide rich empirical information about the epistemic practices that characterize a research field.

Which kinds of scientific knowledge and epistemic practices we consider depends on two major factors: what is relevant to the metaphysical topic of interest and which information is accessible to us. First, we identify only empirical information that seems relevant to the metaphysical topic of interest and to addressing the metaphysical questions that we might already have in our mind. For instance, if we are interested in biological dispositions, then examples that turn out to be non-dispositional after some philosophical analysis are irrelevant. Second, which kinds of empirical information we can consider depends heavily on which empirical information is accessible to us: whether there is scientific research on certain metaphysical topics at all, how the results of scientific research are published or otherwise accessible, which collaborations with scientists are or can be established, whether we use qualitative (and quantitative) methods to gather further empirical data, and so on.

Common strategies to find scientific examples and literature on metaphysically relevant topics are to look at introductory textbooks and to utilize search engines. Textbooks provide an overview of a scientific field and its established scientific knowledge. They can also guide us to more specific examples and research topics, constituting a good entry point that can later be complemented by other sources. For instance, Suárez (2023a) started his analysis of the relation between stem cells and dispositions by carefully inspecting some textbooks on stem cell biology and later moving on to use search engines to find specific research papers. Suárez & Stencel (2020) and Kaiser (2018a) also relied on web search engines including Google Scholar, Dimensions and PubMed Central to find relevant scientific literature. With these search engines it is easy to find published material by using relevant keywords (Currie, Chapter 10, and Pence, Chapter 21, this volume). Kaiser and Müller (2021) more systematically used an ISI Web of Science search for 'boldness' and 'personality' to identify thirty representative empirical studies on boldness, published between 2008 and 2019 and including diverse taxa.

Collaborations with scientists make even more kinds of empirical information accessible to philosophers. In addition to analyzing scientific publications, Suárez and Stencel (2020) established direct contact (via email or via lab visits) with some scientific groups investigating the metabolic and evolutionary functions of the microbiome for their animal host, as well as the biology of bacteria and other microorganisms, to gain first-hand experience of how they were conducting their research. Kaiser and Müller (2021) is a paper co-written by a philosopher and an empirically working biologist. This intensive collaboration made detailed empirical information available that was highly relevant to answering the metaphysical question (step 2), and it enabled intense discussions important for mutually adjusting metaphysical claim and empirical information (step 4).

Being in a joint research project with scientists makes a more diverse set of empirical information accessible, especially about the epistemic practices in a research field. For example, in their analysis of NC^3 mechanisms, Kaiser and Trappes (2023) consider the project plans and experimental designs described in the grant application and research talks, how the biologists report the empirical results of their projects in research talks and publications, and insights from joint discussions (e.g., about scientific concepts) on retreats and workshops. They also used qualitative methods (i.e., a questionnaire and semi-structured interviews) to collect more empirical information relevant to their metaphysical topics of interest (for details on the methods, see Trappes, 2021).

3.2 Step 2: Selecting the relevant empirical information

The first step of applying the method of metaphysics of scientific practice consists in collecting accessible empirical information that is relevant to a broader metaphysical topic. Most of the time, however, we are interested in addressing a more specific metaphysical question or problem (or several). Step 2 thus consists of narrowing down the metaphysical topic and identifying the concrete metaphysical question(s) or problem(s) at stake.

On this basis, it is then possible to discard part of the available empirical information and dig deeper into the empirical information that is relevant to the metaphysical question or problem at hand. While we are analytically separating step 1 and step 2, in practice, they are often not as neatly separated as they may seem. Discarding empirical information because it is not relevant to the metaphysical topic is part of step 1, but discarding empirical information because it is not relevant to the more specific metaphysical question, is part of step 2. Yet, we sometimes conduct both steps simultaneously, so their relationship is intricate.

There are three major reasons for discarding available empirical information: it is not relevant to the metaphysical question; it reveals no innovative metaphysical insights; and it presents rather unreliable knowledge. Regarding the first reason, it is important to formulate the metaphysical question concretely enough to guide the selection of empirical information; the examples in Table 15.1 illustrate this. Suárez and Stencel (2020) specified their metaphysical question by asking why scientists sometimes view symbiotic assemblages as individuals but, at other times, as communities of independent individuals. This led them to realize that the key to answering this metaphysical question was to understand the contrast between the individuality of multicellular organisms, and the individuality of microbial species of the microbiome, when the two interact to form host-microbiome systems. Hence, they focused on research studying each of the elements separately, rather than on research studying them holistically. Similarly, Kaiser (2018b) started with a broad interest in part-whole relations and the human genome (step 1) and then developed a specific interest in the criteria that determine whether a molecule is part of the human genome. This focus led her to foreground empirical information about the specific methods that ENCODE researchers use to individuate genomic parts.

Given the diversity of empirical information that is often available, one might argue that not all kinds of empirical information are of equal value for extracting metaphysical conclusions. Some empirical information might be metaphysically more revealing or may yield especially interesting or innovative metaphysical insights. This is the second major reason for selecting some empirical information over others. For instance, when Kaiser and Trappes (2023) tried to figure out whether NC^3 should be viewed as mechanisms or processes, they focused on empirical information about the reasons that biologists have for naming NC^3 mechanisms, as expressed in their answers to questionnaires. This empirical information is metaphysically much more revealing than information about how biologists study NC^3 and which research questions they address. Similarly, Kaiser and Müller (2021) focused on empirical studies of boldness (rather than other personality traits) because boldness is a metaphysically particularly interesting example: on the one hand, we seem to have clear intuitions about what it means to be bold; on the other, it is far from obvious which behaviors indicate boldness and how it can be demarcated from other personality traits like exploration or aggressiveness.

The claim that not all kinds of empirical information is of equal value for extracting metaphysical conclusions can also be formulated in a more critical, fundamental way, which points to the third reason for discarding empirical information: not all empirical information is a legitimate source for metaphysical knowledge. Since metaphysical claims need to refer to the world (not to our representations and conceptual schemes of it), we can draw metaphysical conclusions only from reliable, well-established sorts of knowledge. Hence, in step 2, we should select only well-established scientific knowledge and reliable forms of epistemic practices. In principle, we agree with this strategy, but we think that it is important not to be too restrictive. Any kind of empirical information from and about scientific practice will be fallible, and therefore, the metaphysical claims developed on this basis will also be "fallible" (Scholz, 2018) and "provisional" (Kaiser, 2018a). Still, there are clear cases of empirical information on which we should not base our metaphysical claims. The penultimate draft of Suárez and Lloyd (2023) contained a discussion of a specific scientific publication that had just been retracted due to some issues with the dataset. While the reasons for the paper's retraction had nothing to do with the philosophical claim that Suárez and Lloyd (2023) were making, they still decided to exclude this paper.

Finally, it is important to note that empirical information identified in step 1 but discarded in step 2 is not necessarily discarded altogether, since it might be relevant for other metaphysical questions that one will address in future research (see the case of Suárez, 2023a; Suárez, 2023b in step 4).

15.3.3 Step 3: Development of preliminary metaphysical claims

The third step consists in using the selected empirical information to develop one or more preliminary metaphysical claims that address the metaphysical question or problem at stake. This can be done solely based on the empirical information, or in connection to the existing metaphysical literature, or by drawing on established metaphysical knowledge, such as the type/token distinction, the intrinsic/extrinsic distinction, the monism/pluralism/eliminativism distinction, or the extension/intension/hyperintension distinction. These distinctions often help to make the metaphysical claim precise and unificatory. In any case, different philosophical methods can be used to develop the metaphysical claim, among them, inductive methods (recall Section 15.2), such as creative abduction and the inference to the best explanation (IBE), or more deductive methods, such as exploring the space of possibilities to determine which answer is supported by the empirical information.

An example of the latter is Suárez and Stencel (2020), who use the empirical information to develop four possible metaphysical claims: (1) pluralism about individuality (i.e., different conceptions of individuality emphasize different biological properties and host-microbiome systems are integrated at some levels but not at others); (2) individuality quasi-eliminativism (i.e., individuality is a mere "name" that is pragmatically used for research interests but with no real metaphysical implications); (3) gradual individuality monism (i.e., biological individuality comes by degrees and host-microbiome systems have a low-degree of individuality); and (4) individuality perspectivism (i.e., whether a host-microbiome system is an individual depends on the perspective of the scientists studying them). When mutually adjusting these four claims and the empirical information (step 4), Suárez and Stencel (2020) found that only the last metaphysical claim, individuality perspectivism, is compatible with the empirical observation that different groups of scientists experimentally and theoretically treat host-microbiome systems unequally.

An example that involves an inference to the best explanation (IBE) is Kaiser and Trappes (2023). Strictly speaking, IBE requires integrating or unifying the relevant empirical information to an empirical phenomenon that is to be explained, developing alternative metaphysical claims, and choosing the one that best explains the empirical phenomenon. Kaiser and Trappes (2023) derive two metaphysical claims from the relevant empirical information, either that NC^3 are processes, or that they are mechanisms. They argue in favor of the latter claim, because it best explains the empirical information, including the reasons that biologists have for calling NC^3 mechanisms.

This example already shows that IBE in its purest form is rarely used in metaphysics of scientific practice. Kaiser and Trappes (2023) develop alternative metaphysical claims and choose the one that best explains the empirical information. However, there does not seem to be a unified empirical phenomenon to be explained by the metaphysical claim. On the contrary, the selected empirical information used to develop the alternative claims seems to be slightly different from the empirical information that then determined which claim to choose. In addition, considering the diversity of available empirical information, it is unclear what could unify or bind together the disparate kinds of empirical information to a single empirical phenomenon. Moreover, it is questionable whether the relation between

empirical information and metaphysical claim is best characterized as a relation of explanation, rather than, for example, as one of evidential support or one of fit.

Sometimes, only the last part of an IBE is properly applied, because the alternative metaphysical claims are not properly developed but rather quickly discarded. In these cases, the metaphysician of scientific practice develops a good explanation but does not extensively contrast it with alternative explanations. For example, Kaiser and Müller (2021) conclude from the empirical studies of boldness that, even though biologists claim to study boldness, they are not measuring it directly but are observing and measuring different kinds of risk-taking behaviors (in different experimental setups) and inferring personality traits from the observed behaviors. What explains this empirical phenomenon best is the metaphysical claim that boldness is a disposition to show risk-taking behaviors in situations involving an actual or potential threat. In this case, we do have a more clear-cut, unified empirical phenomenon, but the alternative metaphysical claims remain implicit.

15.3.4 Step 4: Mutual adjustment

In the final step, the metaphysical claim is adjusted to the empirical information, cycling through the previous steps (in particular, steps 2 and 3), until a reflective equilibrium is reached (Thagard, 1988; van Thiel & van Delden, 2010; Kaiser, 2019) and the metaphysical claim can be considered both adequate and empirically supported. In this context, "adequate" means that the metaphysical claim satisfactorily answers the metaphysical question, and "empirically supported" means that the metaphysical claim is correctly inferred from the selected empirical information, or that it explains the selected empirical information best (compared to alternative metaphysical claims).

There are at least three ways of conducting mutual adjustment and achieving the reflective equilibrium: widening the scope of the analysis and including new empirical information; using IBE to decide which hypothesis is supported best by the evidence (e.g., by exploring which metaphysical claim explains the evidence best); and re-evaluating the empirical information by focusing on that which is primarily relevant to the metaphysical claim. For example, Kaiser (2018a) decided to broaden the empirical evidence by including evidence that was identified (step 1) but not originally selected as most relevant (step 2), for instance, how ENCODE researchers discuss their findings, specify their goals, and place the ENCODE project in a broader context. In contrast, Suárez and Stencel (2020) only evaluated which empirical claim better explained the selected empirical information on individuality, reaching a sort of reflective equilibrium between the evidence and the metaphysical claim. Kaiser and Müller (2021) acted similarly but introduced some technical concepts from the literature on dispositions to capture the metaphysical assumptions that underlie the specific experiments on boldness. Kaiser and Trappes (2023) decided to re-evaluate some aspects of the empirical evidence that they had previously analyzed, to gain stronger empirical support for one of the metaphysical claims.

Step 4 has another interesting result: when one seeks to mutually adjust the selected empirical information and the metaphysical claim(s), new metaphysical questions may emerge that require new metaphysical answers/claims. For example, the empirical information identified for Suárez (2023a) was reused in Suárez (2023b) to answer a different metaphysical question. Importantly, this possibility of further usage of the empirical information only became obvious through the process of mutual adjustment. This allows moving the research forward into new avenues that were not envisioned in step 1, when the metaphysical topic was addressed and available empirical information was identified.

15.4 Overcoming Some Challenges

The method of metaphysics of scientific practice encounters two major challenges. The first is that our biases, in particular the metaphysical views that we hold and that we have defended in the past, influence which empirical information we select (or the empirical information itself). The second challenge is that it could be argued that the method is not actually developing metaphysical claims, but rather scientific claims or epistemological ones. We now explicate these challenges and suggest strategies to overcome them.

15.4.1 Our Biases May Influence the (Selection of) Empirical Information

As discussed in Section 15.3.2, the selection of relevant empirical information (step 2) should be guided by: its relevance to the metaphysical question at stake and consideration of which empirical information is metaphysically most revealing and represents reliable knowledge. The selection should not be influenced by our biases, such as the metaphysical views that we hold and that we have defended in the past, because this endangers the independence of the empirical evidence. In radical cases, it results in reading the metaphysical claims that we want to get out into the empirical information.

The challenge of bias occurs in two different forms: cherry-picking and influencing scientific practice through collaboration. Cherry-picking involves selecting only that empirical information that supports one's metaphysical claim(s) and discarding any other empirical information, particularly that which supports alternative or opposite claims. This biased selection should not be conflated with the legitimate strategy of discarding empirical information because it is irrelevant to the question. In cherry-picking, empirical information is discarded because it goes against one's hypothesis. For instance, it is permissible to discard empirical information about nondispositional biological properties if one is investigating dispositions in biology. However, it would not be permissible to discard empirical information about intrinsic biological properties if one aims to argue that biological dispositions are mostly extrinsic. The latter would be a case of cherry-picking.

The second way that our metaphysical views can bias the (selection of) empirical information is when philosophers collaborate with scientists and, through their interaction, influence how scientists understand and use scientific concepts and which metaphysical assumptions they hold. While these collaborations with scientists are an important part of philosophy *in* science (Pradeu, Chapter 13, this volume; Laplane et al., 2019; Pradeu et al., 2024), bias can influence not the *selection* of empirical information, but rather the empirical information itself. In its most radical form, the metaphysical view that one seeks empirical evidence for gets included in the empirical information itself. This may be characterized as a kind of experimenter's regress (Collins, 1981; Kusch, Chapter 20, this volume) because the metaphysician needs to rely on the empirical information to formulate her metaphysical hypothesis, but then uses the metaphysical hypothesis to guide obtaining new empirical information. In its radical form, this may lead to discarding legitimate empirical information as "failed attempts," based on our own metaphysical hypotheses. In our view, it is not permissible to influence the scientists' epistemic practices to the extent that the metaphysical view that one seeks empirical support for gets included in these practices. However, this does not imply that it is impossible to collaborate closely with scientists while using the method of metaphysics of scientific practice. There are legitimate ways of influencing the empirical information that one relies on, such as contributing to the clarification of scientific concepts, making underlying metaphysical assumptions explicit, and discarding inconsistent or unjustified metaphysical claims. If the method is applied in these

ways, and if one is conscious of the influences one may have, then this challenge can be overcome.

15.4.2 We May Not Be Doing Metaphysics at all

The second major challenge to the method of metaphysics of scientific practice is the argument that it is not doing metaphysics at all, but rather, that metaphysicians of scientific practice are developing either scientific claims (*becoming scientists "in disguise"*) or epistemological claims (*becoming epistemologists*).

As mentioned in Section 15.2, there is an argument that metaphysics must be distinct from particular sciences, and one way of demarcating between them is to say that metaphysical claims and concepts must be sufficiently general (e.g., Paul, 2012). Some philosophers spell out the generality requirement in terms of transdisciplinarity, which says that while scientific concepts usually belong to only one discipline, metaphysical concepts must be aimed at bridging several scientific fields and addressing questions that are not dealt with in only one scientific field (Schurz, 2021; Engelhard et al., 2021; see Ludwig et al., Chapter 1, this volume for transdisciplinarity beyond academic disciplines). Even though developing metaphysical claims based on empirical information from and about scientific practice also involves generalizing about particular empirical information, the concepts that are of interest to metaphysicians of scientific practice (e.g., stemness, NC^3 mechanisms, animal personality trait/ boldness, parts of the human genome) are often disciplinary, not transdisciplinary. Our strategy to deal with this challenge is to resist the assumption that only concepts and claims that are highly general (expressed, e.g., in their transdisciplinary character) are metaphysical. Metaphysical claims can be as specific as scientific ones, and the objects of metaphysical theorizing can be the objects of scientific theorizing. One consequence is that there may be no clear boundary between metaphysics and particular sciences. We adopt this view under the assumption that scientists have genuine metaphysical interests, that scientists can do metaphysics as well, and that metaphysicians sometimes do science.

The argument that metaphysicians of scientific practice are making epistemological claims is slightly different. Recall from Section 15.2 that metaphysics makes claims about the world, not about our knowledge or representations of the world, which is the goal of epistemology. Metaphysicians of scientific practice seek to draw metaphysical claims from scientific knowledge and epistemic practices. However, it is unclear how this step from our knowledge about the world to the world is justified. It seems that there is no plausible justification and that the only thing that the alleged metaphysicians can do is foot stamping ("But our claims *are* about the world!"). Metaphysicians of scientific practice, the argument continues, develop general epistemic claims about scientific knowledge and epistemic practices, which may be interesting but are not metaphysical. This challenge can be countered by pointing to the fact that one criterion for selecting empirical information is that it invokes the most reliable knowledge by drawing on scientific realism. That is, the method of drawing metaphysical claims about the world from scientists' reasoning and investigative practices presupposes that these practices assume a view of how the world must be, if the claims made in these practices are true, and the theoretical terms embedded in them refer to the world. Importantly, metaphysicians of scientific practice do not need to ultimately defend scientific realism before they can start their work. The metaphysical claims that are drawn from biological practice can be interpreted as having a provisional character (Kaiser, 2018a, p. 30), as we assume scientific claims to be fallible. Yet, it is our assumption that our analyses faithfully reflect what the world would be like if the scientists were correct.

To conclude, using the method of metaphysics of scientific practice comes with some challenges that need to be overcome. First, we need to make sure that our biases, in particular, our previous metaphysical views, do not influence empirical information or its selection in problematic ways, by cherry-picking supportive empirical information or by influencing collaborations with scientists to the extent that they adopt the metaphysical claim for which we seek empirical evidence. Second, we need to explain in what sense we are doing metaphysics, countering the idea that metaphysical claims must be highly general and transdisciplinary, and revealing specifically how we presuppose scientific realism.

15.5 Advantages of the Method

Metaphysics of scientific practice has two main advantages: it gives rise to a kind of metaphysics that is scientifically relevant, and it contributes to bridging two philosophical fields that are quite disconnected so far (philosophy of science in practice, and general metaphysics/ metaphysics of science).

First, metaphysics has generally been viewed with suspicion by scientists, and also by many philosophers of science (e.g., in the origins of logical positivism; although see Patton, Chapter 26, this volume). Historically, this suspicion may have emerged from the fact that the object matter of metaphysics is usually quite abstract and distanced from the "real-world" problems that fill the scientific agendas. But metaphysics of scientific practice can be scientifically relevant in different ways: it often addresses metaphysical questions that are also scientific ones or that are at least closely related to scientific questions, such as conceptual questions about stemness, animal personality, and NC^3 mechanisms; it can also reveal implicit metaphysical assumptions and help to discard inconsistent or unjustified metaphysical claims that sometimes permeate scientific practice (e.g., inconsistent criteria of parthood, inconsistent notions of individuality). In doing so, metaphysics of scientific practice is close to reality, and hence it is a form of metaphysics that should not be suspicious to scientists (or philosophers).

Second, metaphysics of scientific practice can contribute to bringing philosophy of science and general metaphysics or metaphysics of science more closely together. Typically, these philosophical fields are perceived as separated from one another, with small exchange between them: philosophy of science focuses on epistemological and methodological issues and pays special attention to how science actually works; general metaphysics and metaphysics of science, in contrast, focus on metaphysical issues and rarely are concerned with the practices of the particular sciences, especially the nonphysical sciences. Metaphysics of scientific practice builds bridges between these fields in at least two ways. One is by using knowledge from metaphysics of science to guide our own research. For example, in our own work on biological dispositions we have relied on the previous work by McKitrick (2003) on the extrinsicality of dispositions to guide our own claim that many biological dispositions are extrinsic. Another way is for metaphysicians of scientific practice to use knowledge from philosophy of science to delve into hypotheses of general metaphysics. For example, our elaborations on the notions of parthood (Kaiser, 2018b) and individuality (Suárez & Stencel, 2020; Kaiser & Trappes, 2021) applied knowledge from philosophy of science.

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