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**The Challenge from Expert Experience. On the Role of Qualitative Methods in Phenomenology of Science**

Harald Wiltsche

Division for Philosophy and Applied Ethics

Linköping University, Sweden

Abstract: Phenomenology of science is supposed to return to the things themselves by getting as close as possible to the level of scientific practice. In doing so, it engages with a broader landscape of scholarship on science—from sociology and STS to analytic philosophy—that likewise seeks to clarify the epistemic structures of scientific practice. What sets phenomenology apart, however, is its aim of faithfully describing the essential structures of expert experience—the very experience scientists undergo as they engage in their research—by means of a first-person perspective. This paper identifies a central methodological difficulty in this regard: the *challenge of expert experience*, namely the difficulty of accessing and describing experiences that require domain-specific expertise. While introducing qualitative methods into the phenomenological toolbox seems a promising route for addressing this difficulty, it brings with it its own set of challenges. Although, as I will argue, there is no straightforward solution to the challenge, a potential way forward lies in focusing more on the collaborative interactions between phenomenologists and scientists during interview-based inquiry, with the aim of fostering *interactional expertise* in Harry Collins’s sense of the term.

Keywords: Phenomenology of science, qualitative methods, descriptive method, phenomenological interviews

1. Introduction

It is a common perception that philosophy of science falls within the domain of the “analytic” branch of modern philosophy, and that, conversely, the “continental” tradition only sporadically achieved the level of detail and technical precision that is necessary to answer the challenges of modern science (Smith, 1994, chapter 1). As phenomenology is typically seen to be linked with the continental tradition, it also seems to be included in this conventional wisdom (Reynolds & Sebold, 2016, p. v): Considering phenomenology’s focus on lived experience, subjectivity, and consciousness, one might initially perceive its applicability to interpreting the “hard” sciences as somewhat limited. Furthermore, certain branches of existential phenomenology—particularly those influenced by Heidegger’s work—adopted a more distant, sometimes potentially adversarial attitude towards the exact sciences.[[1]](#footnote-1) To summarize, then, although phenomenology has experienced a renaissance in several areas over the past years, until recently it was the opinion of many that serious interactions with scientific core disciplines such as physics or chemistry are outside the scope of phenomenological analysis.

The last years have seen a substantial increase in literature showing that this widespread view is largely exaggerated, if not altogether mistaken. First, it is crucial to emphasize that the perception of phenomenology having made only few contributions to modern philosophy of science is partly based on a somewhat idiosyncratic understanding of the concept of science. Despite shifts in the landscape over the recent decades, “mainstream” philosophy of science, particularly in the Anglo-American tradition, is traditionally perceived to concentrate on the core areas of natural science, such as physics or chemistry. While it is accurate that these disciplines have traditionally held a somewhat secondary role in phenomenology, it does not imply that phenomenologists were broadly indifferent to science. In fact, the reality is quite the contrary: Phenomenology has had a strong impact on many of the “human sciences” such as psychiatry, anthropology, or sociology. Furthermore, there is a vibrant tradition of engagement between phenomenology and the experimental cognitive sciences dating back to at least the 1980s (Schmicking & Gallagher, 2010).

Nevertheless, even when we interpret the concept of science in a manner closer to the conventions of mainstream philosophy of science in the Anglo-American tradition, the situation has undergone significant changes in the last few years. One particularly notable instance is the phenomenology of physics, where various authors have recently applied genuinely phenomenological methods to clarify different facets of physical research. While some of these contributions are more historical in nature, focusing primarily on rediscovering the “effaced” tradition of phenomenological interactions with physics in the works of physicists like Hermann Weyl or Fritz London (French, 2023; Ryckman, 2005), others directly engage with contemporary developments (Barzegar, 2020; Berghofer & Wiltsche, 2023b; Bilban, 2020a, 2021; Crease et al., 2021; de La Tremblaye & Bitbol, 2022; French, 2024; Mager, 2021a; Wiltsche & Berghofer, 2020). Nevertheless, the common thread among all these contributions is that phenomenology holds the potential to enhance our understanding of both the experimental and theoretical aspects of physical practice.

In the upcoming discussion, my aim is to add to this growing body of literature by addressing a methodological concern that, to the best of my knowledge, has not been discussed yet. In essence, my argument will be as follows: I start from the uncontroversial insight that phenomenology of science, *qua* being phenomenological, is supposed to return to the *things themselves* by getting as close as possible to the level of *scientific practice*. This is done by employing a *descriptive* method which helps phenomenology to avoid idealized conceptions of science. Ultimately, the aim of phenomenology is to give a faithful description of the essential structures of *expert experience*—the very experience scientists undergo as they engage in their research. Since this aligns with a standard understanding of the phenomenological method, and as this paper is not concerned with defending phenomenology as an overarching framework but rather with exploring a potential internal problem, I regard this as relatively uncontroversial.

There is, however, a fundamental challenge inherent in this approach. As I will argue, a tension arises between the descriptive orientation of phenomenology and the goal of capturing expert experience. Put succinctly, the problem is this: Due to its descriptive nature, the aim of phenomenology of science is to offer accurate descriptions of the essential structures underlying the kind of expert experience scientists undergo as part of their scientific practice. Yet, most phenomenologists are not practicing scientists themselves, and—as I shall argue—expert experience cannot be adequately accessed through readily available sources such as textbooks. This raises a serious concern: phenomenology of science may fall short of describing the very kind of experience it ought to be most concerned with.

While I contend that incorporating qualitative methods into the phenomenological toolbox offers the only viable path toward resolving this tension, doing so entails significant challenges. Drawing on a proposal by Høffding and Martiny, I will critically examine the use of qualitative phenomenological interviews in this context. My focus will be twofold. First, I will explore the complications that arise from interviewees' tendency to reinterpret their own experiences in ways that efface the anticipatory or embodied dimensions of their engagement, thereby risking to distort the very phenomena under investigation. Second, I will address a tension between phenomenology’s resistance to pre-conceived theoretical assumptions and the apparent need to critically filter parts of scientists’ self-reports when these appear distorted by objectivist meta-narratives. Although, as I will argue, there is no straightforward solution to the challenge posed by expert experience, a potential way forward lies in focusing more on the collaborative interactions between phenomenologists and scientists during interview-based inquiry. In this regard, I draw on Harry Collins’s work on *interactional expertise* to articulate the kind of epistemic familiarity phenomenologists require in order to conduct interviews that contribute meaningfully to a normatively oriented phenomenology of science.

Before diving into the main discussion, I would like to make a preliminary remark: In addition to addressing a methodological problem that I believe warrants discussion on its own, this paper is intended to spark new collaborations between fields that, to my knowledge, have rarely interacted in the past. Over the past decade, phenomenological research focusing specifically on the core areas of the “hard” sciences has gained significant momentum (see, for general overviews, Berghofer & Wiltsche, 2024; Crease, 2011; Kochan & Schmid, 2011). A notable characteristic of much of this work is the strong influence of “mainstream” philosophy of science in the analytic tradition, both in terms of the topics addressed[[2]](#footnote-2) and the general methodological approach. Regarding the latter, it is particularly striking that, beyond traditional phenomenological methods (such as eidetic description or genetic analysis) and methods more common in analytic philosophy (such as conceptual analysis or thought experiments), the primary qualitative approach employed has been a historically oriented analysis of case studies (Bitbol, 1996; Wiltsche, 2017, 2018). This paper is a call to expand the range of qualitative methodological tools employed in the phenomenology of science and to foster stronger engagement with fields where these tools—despite differing topical orientations—have already been applied extensively and effectively.

1. Phenomenology of Science

In the *Amsterdam Lectures* from 1927/28, Edmund Husserl characterizes his phenomenological project as a “radicalizing of an already existing phenomenological method which individual natural scientists […] had previously […] practiced” (Husserl, 1997, p. 219). Husserl mentions the Austrian physicist Ernst Mach as a concrete example of a thinker who critically reacted “against the threatening groundlessness of theorizing [and] against a mode of theorizing in mathematical speculations and concept-forming which is distant from intuition” (ibid.). And, indeed, the concept of a “phenomenological physics” (Mach, 1986, p. 333) did play a crucial role in Mach’s overall system (Berg, 2015, p. 35 ff). The meaning of the concept, which is still invoked in contemporary physics, is best explained by a simple example, such as Snell’s law.

Snell’s law, also known as the Law of Refraction, describes the relationship between the incidence angle () and the refraction angle () of a light wave when it traverses from one medium to another. The law is expressed as , where *n1* and *n2* represent the refractive indices of the two media. When physicists characterize such a law as phenomenological, they do so because it only provides a mathematical description of the relationship between variables without being derived from fundamental theoretical principles. Another way to say this is that Snell’s Law is phenomenological because it merely “saves the phenomena” without offering deeper theoretical explanations of why the variables are interconnected in the specified manner. According to Mach, physics should be as phenomenological as possible. While he acknowledged that occasionally, ”deep” explanations can be instrumentally valuable, his overarching aim was to “do away with all metaphysical elements in the exposition of natural science” (Mach, 1986, p. 333) to achieve the objective of a “general, all-encompassing physical phenomenology” (Mach, 1903, p. 277; my translation). Instead of engaging in “deep” explanations, this physical phenomenology would confine itself to the observable level. Thus, in Mach's view, a phenomenological physics would strive to stay as close as possible to the “things themselves”, aligning with the goal of physics to account for the physical world around us.

In addition to its historical significance, my reference to Mach aims to underscore a concept that gained considerable prominence in the subsequent phenomenological movement. While Mach was worried that too much emphasis of deep explanations and the reification of mathematical models could mislead physics into the realm of metaphysical speculation, Husserl identified a similar issue within philosophy. Throughout his life, one of his primary aims was combating what he disdainfully referred to as “standpoint philosophy”—a tendency to operate from unquestioned assumptions, thereby constraining problems within a specific, and possibly contrived, theoretical framework. Contrary to this, phenomenology should be driven by a deep respect for the *phenomena*, that is, the things as they present themselves in experience. Phenomenologists generally agree that numerous philosophical issues could be resolved, or indeed, often wouldn’t even emerge, if we refrained from imposing pre-existing frameworks and devoted more energy to accurately describing the phenomena.

How does this apply to the phenomenology of science, that is, to the endeavor of elucidating modern science within the context of a phenomenological framework? Regardless of the specific methodological tools that phenomenologists may wish to utilize, the most essential trait of a phenomenological approach to science is the strong commitment to not start from an idealized notion of science, but rather to return to *scientific practice*.[[3]](#footnote-3) Concretely, this implies two key points: First, phenomenologists generally dismiss the idea that philosophical arguments should instigate changes or modifications in particular theories or the way science is done.[[4]](#footnote-4) Second, phenomenological attempts to elucidate scientific cognition and practice does not start with the philosophers’ conceptualization of what science could or should be, but rather with the description of the actual experience of science as it is practiced by its practitioners. The resulting image is one of a cognitive division of labor between science and phenomenology. While “[t]he construction of theories […] will always remain the home domain of the [scientist], […] the philosopher enquires into the essence of theory and what makes theory as such possible” (Husserl, 2001, pp. 158–160).

As we have seen, the phenomenology of science is, in an important sense, *descriptive*. It refrains from starting with preconceived ideas of what science ought to be. Instead, it bases its analyses on a description of *scientific practice* that must remain free from prior ontological or metaphysical assumptions. While this is undoubtedly a key aspect of the phenomenology of science, it doesn’t solely define its uniqueness. Other fields, such as the sociology of science or science and technology studies (STS), also commence with a description of scientific practice. Therefore, more is needed in order to understand what sets the phenomenology of science apart from other meta-scientific endeavors. In what follows, I will begin by offering a preliminary attempt to distinguish the phenomenology of science from other descriptive approaches to scientific practice. It is important to note that this initial demarcation is not intended to be definitive or exhaustive. Given the complex ways in which methods and perspectives intersect across phenomenology, sociology of science, STS, and philosophy of science, my aim here is simply to sketch an *ideal type* in Max Weber’s sense (Sun, 2024). While this first characterization is meant to provide a rough orientation within the current methodological landscape and phenomenology’s place in it, I hope that the concrete case study presented in Section 3 will offer a clearer sense of the aims and aspirations of a phenomenological approach to scientific practice.

Contemporary scientific practice has traditionally been studied using third-person methods such as surveys, secondary data analysis, or ethnographic fieldwork based on non-participant observation. These approaches are common in many areas of the sociology of science and STS, and more recently also in “mainstream” analytic philosophy of science (Nersessian & MacLeod, 2022; Wagenknecht et al., 2015). In contrast, perhaps *the* defining feature of the phenomenology of science is its commitment to a first-person methodology—one that aims to describe scientific practice and the experience that accompanies it *from the perspective of the experiencing subject*. While the phenomenological framework is flexible enough to incorporate second- and third-person approaches and data (Martiny et al., 2021), it remains widely accepted that a distinct kind of first-person inquiry remains *the* hallmark of phenomenological inquiry.

While first-person inquiry plays a central role in phenomenology, it would be an overstatement to suggest that its use is unique to this tradition. First-person approaches are also part of the methodological repertoire in sociology of science and STS. However, when we examine the motivations and goals behind their use, important differences become apparent. In STS, first-person approaches are employed to “provid[e] models for participation and [for] engaging scholarship through the lens of explicit lived experience” (Cohen & Galusky, 2010, p. 6). This is typically achieved through personal narratives that offer “different possibilities for argument construction [and] unique opportunities to speak to audiences beyond peers alone” (Cohen & Galusky, 2010, pp. 6–7; see also the other articles in the special issue edited by Cohen and Galusky), or through situated intervention to the fields that are being studied (Zuiderent-Jerak, 2015). Phenomenology, by contrast, examines *lived experience* from a *first-person perspective* with the explicit *normative* aim of uncovering the *essential structures* that underlie all such experiences. While this normative stance aligns phenomenology with recent efforts to integrate ethnographic and other qualitative methods into “mainstream” philosophy of science (Nersessian & MacLeod, 2022; Wagenknecht et al., 2015), the key difference here lies in phenomenology’s emphasis on the first-person description of *lived experience* as its primary object of study.[[5]](#footnote-5)

The aim of the preceding remarks has been to highlight the distinctive middle ground that the phenomenology of science occupies within the current theoretical landscape. On one side, it shares the explicitly normative aspirations of recent efforts to integrate qualitative methods into “mainstream” analytic philosophy of science. Yet it diverges from these approaches in its emphasis on first-person description of lived experience. On the other side, while first-person approaches to the experiential dimension of scientific practice are also found in the sociology of science and STS, phenomenology advances a normative ideal that is relatively uncommon in those fields.[[6]](#footnote-6)

To summarize, then: phenomenology examines lived experience from a first-person perspective, with the explicit normative aim of uncovering the essential structures that underlie such experiences. To gain an initial understanding of what this means, consider the horizonal structure that, from a phenomenological perspective, characterizes all lived experience: When an observer identifies a piece of equipment on a laboratory workbench, they perceive it as a three-dimensional object in space. However, upon closer reflection, what is truly sensorially presented at any given moment is not a three-dimensional object, but rather a single aspect of the object, its current front side. To be sure, the observer could use their kinaesthetic capabilities to move around the object, and make its current back side the new front side, and vice versa. However, this would not change the fact that the intended object is always given in perspectives and that, more generally, objects always and necessarily have more parts, functions, and properties than can be actualized in one single blow. The fact that our intentions towards things (“That piece of equipment over there”) always transcend the sphere of direct sensory givenness (“The thing’s currently facing side”), that intending is always “*intending-beyond-itself*” (Husserl, 1960, p. 46), is not a problem that must somehow be remedied. It is rather a phenomenologically discoverable feature of lived experience itself.

The point of this example is to provide a first taste of what I mean when I say that the aim of phenomenology is to give a first-personal description of the essential structures of lived experience. In order to flesh this out even more, and in order to show how this applies to the analysis of scientific practice, I now wish to examine a example which is more relevant for phenomenology of science, specifically, a phenomenological analysis of how mathematical models serve as cognitive lenses for constitution of scientific reality.

1. An Example: A Phenomenology of Scientific Modeling

Models have arguably been among the most fervently debated subjects in recent “mainstream” philosophy of science. Considering their pervasive application across virtually all domains of modern science, this comes as no surprise: Lotka-Volterra models serve as our foundation for comprehending and forecasting the dynamics of biological systems, especially the interplay between predator and prey populations. The standard solar model is our tool for understanding the structure, evolution, and energy production of the Sun, with a particular focus on the proton-proton reaction at its core. The standard model of particle physics is our guide to understanding and predicting the interactions of particles such as quarks or leptons through fundamental forces like electromagnetism, and the weak and strong nuclear forces. In each of these instances, our understanding of the respective target system does not come from direct interaction, but rather from a mathematical model.

In the “mainstream” debate, philosophers of science are interested in the ontological status of models, their relationship to theories, the epistemology of how we gain knowledge about empirical target systems through the interaction with a mathematical surrogate, or the fact that almost always models provide us with an understanding of the target system although they contain intentional distortions such as point masses or frictionless planes. On an even more fundamental level, philosophers examine the “unreasonable effectiveness” of mathematics for the formulation of models and the representational relationship which many assume must exist between a model and its target system. With regard to the latter question, some authors explicitly “argue for an intentional conception of representation in science that requires bringing scientific *agents* and *their intentions* into the picture” (Giere, 2009, p. 269; my emphasis; Suárez, 2004). This view is opposed by those who hold “that the semantics of models as scientific representations should [only] be based on mind-independent model-world relation” (Rusanen & Lappi, 2012, p. 317) because an “agential” notion of “representation is too dependent on the attitudes of the [model] user” (Ruyant, 2021, p. 545) and hence not deemed “objective enough” for science.

To the best of my knowledge, a systematic phenomenological treatment of models in science does not yet exist. However, what becomes apparent from the available studies (Islami & Wiltsche, 2020; Wiltsche, 2017, 2018) is that a phenomenological approach does not only acknowledge the essential role of the modeling agent but even goes one step further by taking the perspective of the model user as the *starting point*, thus aligning with the aforementioned credo of proceeding from *first-person descriptions of scientific practice*.

To make this more conrete, imagine the example of an experimental setup where an EF-probe measures the electric field strength at various points between two charged conductors.[[7]](#footnote-7) Imagine furthermore two observers, Audrey and Dale, who follow the experiment and describe their first-personal experience. Dale, who knows nothing about physics, might report seeing a yellow-black electronic device with a display that shows different digits depending on the device’s location. The horizonal structure of Dale’s experience is rooted in everyday practice: By intending the EF-probe as “a yellow-black electronic device”, Dale generates anticipations typical of conventional lifeworld objects. For instance, he anticipates that the device will reveal a momentarily hidden back side or remain the same size when moved from A to B. Conversely, other aspects of the scenario remain unspecified. For instance, since Dale views the EF-probe as a typical lifeworld object without scientific significance, he has no specific anticipations about how the digits on the probe’s display might change.

Note, however, that Dale’s experience of the situation heavily relies on his ability to track invariances over the course of the entire perceptual episode. When Dale uses his kinaesthetic abilities to change his vantage point, some aspects of the device undergo significant changes due to his movement. For example, depending on the lighting conditions, the specific color qualities of the device will vary greatly based on the position from where the device is observed. Other aspects, however, will remain stable. For instance, the angular relations between Dale and each side of the device remain invariant, regardless of the observer’s perspective. A competent observer bases their (usually implicit) claims to (varying strengths of) perceptual objectivity on such invariances.

Although Audrey and Dale are in close spatiotemporal proximity and seem to visually attend to the same scenario, the *how* of Audrey’s intentional directedness is significantly different. Audrey is a practicing physicist who intends the situation in front of her through the mathematical model . Just as we “look through” a freehand drawing of a circle to perceive an ideal geometrical circle, Audrey “looks through” the materiality of the EF-probe, perceiving it as a dimensionless, geometrical point associated with a scalar factor and a vector quantity. Although the way Audrey constitutes the situation differs significantly from Dale, her experience remains horizontally structured and heavily reliant on the ability to identify invariances. Similar to how the perceptual objectivity of shape is constituted based on the lawful angular relations between the observer’s position and the sides of the perceived object, Audrey can anticipate the exact relationship between the force acting on a particle with a known charge and the measured electric field at a specific point *P*. Just as simple perceptul encounters with everyday objects always and invariably occur within a horizon of anticipated further experiences, the model too serves as the horizonally structured lens through which the experimental situation is constituted.

However, acting as a cognitive lens for constituting particular segments of reality is just one possible role for a model such as . For instance, if Audrey encounters inconsistencies between the model and the data, she might begin modifying the model. Although working on the model would still qualify as a form of scientific practice, the accompanying experience would differ greatly from the earlier situation of attending to a scientific experiment. Instead of “looking through” the model to constitute an experimental situation in a specific physico-mathematical manner, the model would now become the sole object of Audrey’s intentional focus.

As this brief description illustrates, phenomenology of science differs both from “mainstream” philosophy of science and broader phenomenological analyses by highlighting the previously overlooked and distinctively unique role of mathematical models. In situations where models are not the direct objects of a scientist’s attention but instead serve as the “cognitive lens” enabling a particular process of “meaning bestowal”, a model functions as a highly sophisticated *noema*—the specific *meaning* through which an experimental situation is intended.[[8]](#footnote-8) While models resemble more conventional noemata by acting as horizonally structured spaces of possibilities for further experiences, their distinctness lies in their mathematical and therefore idealized nature. However, when scientists shift their focus from engaging with an experimental situation through a model to examining the model itself, both the quality and the structure of the accompanying experience changes significantly. The model no longer acts as a noema through which an experimental situation is intended; instead, it becomes an abstract object of intention, subject to manipulation through the appropriate mathematical operations. To adequately describe this dual character of models is one of the unique contributions of a phenomenology of science perspective.[[9]](#footnote-9)

This is not the place to discuss further details of a phenomenological account of models or to comment on its advantages and possible disadvantages. What I want to emphasize is that, as we have seen, a phenomenological analysis does not begin with preconceived ideas about what science is, what models are, or how scientific representation comes about. Instead, phenomenology starts with a careful first-person description of the various experiences that accompany different ways in which models are actually used in diverse scientific contexts. The hope is that this methodological approach not only provides a more realistic understanding of how models function in actual scientific practice but also serves as a promising strategy for avoiding metaphysical hypostatizations of over-idealized construals of science.

1. The Challenge of Expert Experience

Having introduced some of the basic tenets of the phenomenology of science and provided a concrete case study, this section turns to the central problem of the paper: the challenge of expert experience. As noted in the introduction, the issue is this: although phenomenology of science is committed to delivering accurate, first-person descriptions of the kinds of experiences experts undergo in their scientific practice, phenomenologists may struggle to meet this standard. Their lack of scientific expertise risks making it impossible to describe the very experiences they are, by their own meta-philosophical commitments, obligated to address. To clarify how this problem emerges, let us take a step back and trace its development step by step.

It is generally accepted among phenomenologists that first-person description is the methodological *sine qua non* of phenomenology. In the words of Amie Thomasson:

There must be some means of first-person access to experience if phenomenology […] is to be possible at all. For phenomenology is supposed to provide the basis for a first-person study of the mind, and thus requires some first-person way of acquiring knowledge about mental state types, their contents, and so on. If there is not, then the only possible means of acquiring knowledge of the mind will involve third-person access via external behavioral or physiological studies. (Thomasson, 2005, p. 115)

Although this general statement also applies to the phenomenology of science, there is a notable difference that matters in the context of this paper: Much of phenomenology aims to unearth the structures of intentionality that are so general they ideally characterize any consciousness whatsoever. In contrast, the focus of the phenomenology of science is more restricted: It is concerned with the structural features of the kind of experience that accompanies a very specific area of human engagement, namely scientific practice. As the earlier example of Dale illustrated, for a subject to have this kind of experience, they must possess certain specialized skills and expertise. In other words, while phenomenology generally seeks first-person descriptions of experience, the phenomenology of science focuses on *expert experience*, which is accessible only to subjects who meet certain knowledge and skill requirements in their relevant, highly specialized fields. Without meeting these requirments, a subject would simply not undergo this specific kind of experience.

Once we recognize *expert experience* as the core subject in phenomenology of science, we can start to understand the potential methodological challenges inherent in this approach. Although it is crucial to not conflate phenomenological description with introspection (Cerbone, 2012; Thomasson, 2005), it is still undeniable that, more often than not, phenomenologists use their own mental life as the target of their descriptive efforts. However, in the phenomenology of science this practice can lead to potential issues. The problem, in a nutshell, is this: While a phenomenologist analyzing the experience associated with the use of a mathematical model will have to understand the model and must have the basic skills to apply it correctly—otherwise the mathematical symbols or lines of code will remain incomprehensible altogether—, it still remains debatable whether this level of expertise can compare to that of a scientist who, after years of graduate and postgraduate training, uses the same model daily, under varying circumstances. The problem becomes particularly acute if one realizes that there is a fundamental difference between, first, the level of theoretical textbook understanding of the inner workings of a model within a particular theoretical frame and, second, the level of practical knowledge about the model’s behavior under typical circumstances, often without carrying out any actual calculations. A few concrete examples will help clarify this point.

Every practicing physicist will confirm that there is fundamental difference between explicit textbook knowledge and practical know-how that comes with daily practice, which is hard, if not impossible, to explicate fully. For instance, there is a difference between having a theoretical understanding of what the Lorentz factor in relativity theory is, and immediately seeing in an equation that the difference between *v* and *c* is large enough to make negligible for all practical purposes, even without doing the calculations. Similarly, there is a difference between having a theoretical understanding of what commutation relations between operators in quantum mechanics are and why they matter, and the ability to tell from typical symmetries or common operators that it pays off to check for commutation relations in a concrete case. The distinction is even clearer if we move into experimental science where the practical dimension of tacit, never fully explicable knowing-how is an essential part of any scientific endeavor (Heelan, 1977; Polanyi, 2015; Rheinberger, 2023). Just as driving thousands of kilometers on icy Swedish roads allows one to directly anticipate road conditions without much conscious thought, skillful scientific practice transcends the sphere of “well-behaved”, and thus easily accessible textbook knowledge.

If the expert experience characteristic of scientific practice crucially involves the sphere of practical knowledge I have just described, but if this sphere of practical knowledge is not accessible through conventional textbooks, then phenomenologists of science run the serious risk of being unable to describe the kind of experience they should be primarily interested in, according to their own methodological maxim. Or, to express it differently:

1. The most essential trait of a phenomenological approach to science is the commitment to return to the things themselves.
2. In phenomenology of science, the things themselves are the *expert experiences* practicing scientists undergo as part of their scientific practice.
3. Since most phenomenologists are not practicing scientists,[[10]](#footnote-10) they fail to describe the respective expert experience and hence the things themselves.

This is what I would like to call the *challenge from expert experience*.

Building on this description of the problem from expert experience, let me briefly return to my earlier case study. At first glance, one might assume that my description of the phenomenology of mathematical modeling is simply a random instance of a broader issue—one that isn’t even unique to the analysis of scientific practice but arises in describing any form of skilled practice or expertise without being an expert oneself. However, there are several reasons why my earlier case study cannot be entirely reduced to this broader issue.

First, the ability to employ mathematical models to explore phenomena otherwise inaccessible is not simply one skill among many. Within the core disciplines of the natural sciences, such as physics and chemistry, and extending to fields like economics, ecology, and archaeology, the constitution of target systems through mathematical models has become a cornerstone of scientific practice since the 17th century. Indeed, modeling has become the *sine qua non* of modern science. Consequently, to overlook modeling is not merely to disregard one aspect of scientific activity but to ignore one of the defining features of contemporary scientific methodology.

However, the special role of models is not only due to their ubiquity. Mathematical models also hold a special status because, second, many specific problems within particular disciplines cannot even be properly formulated—let alone meaningfully discussed—without the ability to constitute relevant phenomena through models. Indeed, there are well-documented cases where the use of natural language and its associated ontological categories has led to pseudo-problems that arise solely as artifacts of employing an inadequate, non-mathematical conceptual framework.[[11]](#footnote-11) Consequently, ignoring modelling means disregarding a crucial component of how scientists gain cognitive access to the “world of science”.

Third and finally, the ability to constitute phenomena through mathematical models serves as a paradigmatic example of a skill that cannot be acquired solely through studying conventional textbooks, thus making it much harder to analyze for philosophers of science. As previously noted, textbook knowledge is inherently incomplete because it primarily focuses on one aspect of modeling—the mathematical frameworks in which models are expressed and the formal rules governing their manipulation. What is only indirectly conveyed, typically through practical problem exercises placed at the end of chapters (Kuhn, 1981), is how models are employed to constitute theoretical phenomena and, subsequently, how they are applied in real-world contexts. What makes this aspect of modeling—predominantly reliant on knowing-how rather than easily formalizable knowing-that—particularly elusive for philosophical analysis is its transmission through the informal dimensions of education, such as laboratory classes and project-based work. These skills are further refined and solidified through repeated application in practical contexts, making them challenging to pin down within conventional philosophical approaches (Galison, 1987; Vincenti, 1990).

These remarks are intended not only to emphasize why mathematical modeling is an essential subject for any philosophical approach to science but also to show how phenomenology offers a uniquely effective framework for examining the key roles that models play. As my earlier example of Audrey was meant to illustrate, phenomenology provides valuable insights into how models help constitute scientific phenomena and how their roles can vary—whether they serve as “cognitive lenses” for the constitution of phenomena or as direct objects of scientific attention. This dual perspective makes phenomenology better equipped than other frameworks to analyze the functions of models.

However, connecting this discussion back to what I term the challenge from expert experience, the fundamental problem connected to this approach reemerges. Put simply, although my account relied heavily on a description of Audrey’s first-person perspective in constituting the phenomenon of electromagnetic field strength, *I am not Audrey*. While “Audrey” functions as a placeholder for an imagined physicist, the first-person description I provide reflects *my own experiences*, not those of an actual expert. This leads to the central conundrum addressed in this paper: How can phenomenologists access the level of expert experience when they themselves are often not the experts who possess such experiences?

1. Qualitative Methods to the Rescue?

Given the points made in the previous section, some readers might argue that I am creating a problem where none actually exists. They might point out that in many areas of applied phenomenology and the social sciences, it is standard practice to describe experiences to which the phenomenologist or social scientist does not have direct access. Furthermore, there are established methods that allow us to deal with this problem by “extending our descriptive grasp”. The most relevant method are qualitative and specifically phenomenological interviews. If this is correct, then my challenge from expert experience can easily be addressed with existing methods. To consider this response in more detail, let us examine an influential article discussing phenomenological interviews and their potential applications.

Høffding and Martiny start their discussion with the following general statement about methodology:

“Although phenomenology is not an entirely homogenous tradition, in this context of the interview, we take it to conform to some general commitments. The first of these is the classical dictum to go ‘to the things themselves’, meaning that we take experience seriously, beginning […] with the first-person perspective of the [expert].” (Høffding & Martiny, 2016, p. 542)

Given the importance I have placed on the methodological maxim to start from the things themselves, this indeed sounds very promising. Here is how the authors continue:

“[T]he phenomenological interview consists of two intricately linked tiers. The first is the interview itself […], while the second is a phenomenological analysis of the first tier. In the first tier, we generate descriptions of experiential content and gain intimate first-hand knowledge of the interviewee’s lived experience. In the second tier, relying on the phenomenological method […], we analyze these descriptions, in such a way that they might be generalized to say something about experiential structures and hence subjectivity as such.” (Høffding & Martiny, 2016, p. 543)

Let’s begin our discussion with the first tier. Since in phenomenology of science we are interested in the essential structures of the kind of expert experience that accompanies scientific practice, the interview phase would presumably consist in letting scientists use their own words to describe their experience of engaging in particular scientific activities. However, based on my own conversations with scientists, I am skeptical whether this is a reliable way to “gain intimate first-hand knowledge of the interviewee’s lived experience”. The reason for my skepticism is that members of modern scientific culture generally struggle to describe experiential content without straightforwardly objectifying it through some kind of scientific meta-narrative. Even when we ask for relatively simple, pre-scientific experiences, such as perceiving a coffee cup, it is much more likely to hear a story about photons, biochemical pathways and photoreceptor cones than an acknowledgment of the essential law of givenness-in-adumbrations (Wallner, 2021; Wiltsche, 2013). However, the situation is even worse when practicing scientists are asked to describe their scientific practice. As Husserl argued at length in *The Crisis of European Sciences*, modern culture since the scientific revolution has never managed to properly reflect on the constitutional origins of the mathematical idealities from which our scientific models are built. This omission opened the floodgates for all kinds of metaphysical hypostatizations of science and led to a widespread objectivist mindset whose fundamental mistake it is to “take for *true being* what is actually a *method*” (Husserl, 1970, p. 51). The problem with this tendency to reify models is not only that it is based on the “fallacy of misplaced concreteness”, which is “the error of mistaking the abstract for the concrete” (Frank et al., 2024, p. 24). Objectivism also poses a threat for the use of phenomenological interviews because, rather than reflecting the “things themselves”, scientists’ self-reports are likely are likely shaped by theoretically motivated reinterpretations that may obscure the horizonal structure of expert engagement. Since science textbooks are far from neutral when it comes to ontological, metaphysical, and epistemological hypostatizations of scientific practice (Blachowicz, 2009), we must expect that scientists’ descriptions of their experiences in doing science are influenced by the objectivist interpretations they have acquired as part of their training.

The difficulty to describe one’s experience without distorting it through meta-narratives is, of course, not unique to scientists. The literature on the methodology of phenomenological interviews offers various accounts of why individuals often struggle to access and articulate their own subjective experiences (Vermersch, 1999). For example, Claire Petitmengin highlights the problem of “absorption in the objective” (2006, pp. 233–234), referring to the way in which the focus on the practical ends of an activity typically obscures the lived experience of the activity itself. This, in turn, increases the likelihood of falling into what Petitmengin terms the “confusion between experience and representation” (2006, p. 235)—the aforementioned tendency to substitute a theoretical conceptualization for the experience itself. However, although issues such as these are arguably relevant for all interview situations, I would still argue that scientists are particularly susceptible to objectivist distortions of their own expert experience because of their deep immersion in the scientific image from which these distortions emerge. This, in turn, is also why the challenge of expert experience plays out differently for scientists than for other types of skilled experts. Of course, the difficulty of accessing the priviliged forms of experience unqiue to highly trained individuals also arises in other domains, such as phenomenological studies of healthcare professionals (Sibeoni et al., 2020) or musicians (Høffding, 2018). However, the crucial difference is that scientists, unlike these other experts, engage in an enterprise that explicitly aims to interpret reality from within the practice itself. To put it bluntly: no matter how refined the experience of a professional violinist may be, it is typically not part of their self-understanding to treat their musicianship as a means for constructing an overarching interpretation of the world.

If my concerns are justified, then scientists’ self-reports may not provide a reliable starting point for phenomenological analyses of scientific practice, as their descriptions of experience are often shaped by objectivist presuppositions that can obscure key experiential structures.[[12]](#footnote-12) However, a defender of phenomenological interviews could respond to my worry by arguing that it is somewhat naïve to expect a completely unaccompanied interview to generate material suitable for phenomenological analyses. Interviewees must be primed for a phenomenological interview, perhaps by familiarizing them with basic phenomenological concepts like “horizonal intentionality,” “noesis,” “noema,” “epoché,” or “reduction.” By incorporating these tools, scientists might become more attuned to the aims of phenomenological analysis and abstain from an objectivist construal of their own expert experience.

However, it seems to me that such priming of interviewees isn’t methodologically sound either. Specifically, introducing scientists to the main building blocks of the phenomenological method poses a problem known to ethnographers as the “Hawthorne Effect” (O’Reilly, 2008, pp. 209–211; Oswald et al., 2014). When ethnographers immerse themselves in a community to observe and document cultural practices, their presence and conceptual tools inadvertedly influence the very cultural practices they seek to study. Familiarizing scientists with phenomenological concepts seems to be a clear instance of the “Hawthorne Effect.” If interviewees adopt phenomenological terminology not as a result of proper phenomenological training but due to the interviewers’ intervention, what makes us believe that the resulting interview material brings us any closer to the things themselves than any other theoretically induced construal of expert experience?[[13]](#footnote-13)

A critic might argue against my analysis by suggesting that researchers who routinely use qualitative interviews as part of their methodological toolkit would never propose priming interviewees with phenomenological terms such as “horizonal intentionality,” “noesis,” “noema,” “epoché,” or “reduction,” thus rendering my concerns about the “Hawthorne Effect” somewhat irrelevant. Indeed, most phenomenologists using qualitative methods would freely admit that providing interviewees with conceptual resources of this kind would represent a clear case of biasing the interview outcomes—an effect that would only be marginally better than accepting the objectivist distortions of expert experience without question. However, even if this response is valid, it remains unclear how the underlying problem I am addressing can be effectively resolved.

On the one hand, it seems difficult to argue that scientists with no familiarity with phenomenology could come close to providing the type of description of modeling experience I outlined in Section 3. Those of us who teach phenomenology to students are well aware of the challenges involved in helping novices recognize phenomena such as the horizonal structure of experience, *despite the fact that this structure arguably underlies every experiential episode they have ever undergone*. Phenomenology as a discipline would not be possible if this were considered an insurmountable problem. The explanation for why phenomenological description must be learned, despite the fact that everything it reveals is always already operative, is that phenomena such as the horizonal structure of experience are so familiar to us that we fail to notice them under normal circumstances. This argument parallels the Pythagorean explanation for why we do not hear the harmony of the spheres: we no longer perceive it precisely because it is always present. In line with this reasoning, the inability of scientists to provide phenomenological descriptions of their expert experience is both expected but does not inherently challenge the viability of a phenomenology of science.

However, if, as previously discussed, equipping scientists with the conceptual tools for phenomenological descriptions is not a viable option either, one might question what the solution to this problem could be. Once concrete suggestion comes from Claire Petitmengin who recommends “a small training exercise to raise the interviewee’s awareness of [the] different dimensions [of experience]”. According to Petitmengin, “this training will help the interviewee access the ‘attentional position’ required to become conscious of these different dimensions of his experience” (2006, p. 246). I don’t deny that this strategy might be the right one in principle, and I will return to this and other proposals in section 7 of this paper. However, my general problem with many of the available solutions is that they are not detailed enough to show how they would work in the kinds of situations I am focusing on here.[[14]](#footnote-14) For example, if I want to describe how mathematical models take on different roles when an experimentalist in my institution’s quantum information lab shifts from working with an abstract model—represented as symbols on a whiteboard—to “looking through” that model to reconstitute the experimental setup on her lab bench, it is unclear how to create useful training exercises without relying on high-level conceptual resources like “horizonal intentionality,” “noesis,” “noema,” “epoché,” or “reduction.” Given that concerns about unintentionally priming interviewees are a common critique of study designs (Fernandez, 2024), more explicit methodological debates on this issue are needed.[[15]](#footnote-15)

1. From the first tier to the second tier

So far, I have only been discussing what Høffding and Martiny call the first tier of the phenomenological interview, the stage during which “we generate descriptions of experiential content and gain intimate first-hand knowledge of the interviewee’s lived experience” (Høffding & Martiny, 2016, p. 543). But what about the second tier, the stage during which “we analyze these descriptions, in such a way that they might be generalized to say something about experiential structures and hence subjectivity as such” (Høffding & Martiny, 2016, p. 543)? Perhaps phenomenologists of science should not place so much emphasis on the mere collection of interview material but instead be more confident in their interpretational skills and their ability to distinguish between theoretically induced objectivations of scientists’ self-reports and phenomenologically accurate descriptions. Indeed, there are voices within phenomenology that seem to advocate for precisely this attitude:

“Indeed no methodological approach to experience is neutral, it inevitably introduces an interpretative framework into its gathering of phenomenal data. To the extent that this is so, the hermeneutical dimension of the process is inescapable: every examination is an interpretation, and all interpretation reveals and hides away at the same time. But it does not follow from this that a disciplined approach to experience creates nothing but artifacts or a ‘deformed’ version of the way experience ‘really’ is.” (Varela & Shear, 1999, p. 14)

The underlying sentiment of this statement appears to be straightforward: Whether we are reading a text or observing an experimental setup, every interaction with the world is, according to this view, interpretive. This means we selectively experience situations, highlighting certain elements while disregarding others. If this selective perception is inherent in all experiences, then it seems reasonable to trust our abilities to interpret qualitative material gathered from interviews, and consider what Høffding and Martiny call the second tier as the crucial part of the phenomenological interview.

Yet, while this attitude might be helpful in some areas of phenomenology,[[16]](#footnote-16) I am skeptical about its usefulness in the phenomenology of science. To illustrate this point, consider the concrete example of a physicist who, in reporting her experience of identifying the SU(2) symmetry group in a quantum model, immediately re-frames this experience in an objectivist vein as a direct encounter with angular momentum and, consequently, with the deep structure of mind-independent reality. In doing so, however, she overlooks the aniticipatory structure that underlies her engagement with the model—namely, the expert’s prereflective readiness to “see” the SU(2) invariance as salient, meaningful or even “there”. As discussed earlier, this structure, phenomenologically construed, is not a theoretical construct which, by virtue of its explanatory, predictive, or technological level, would warrant reification. Rather, it is an invariant feature of how experts relate to their subject matter in a lived, situated and embodied manner. From a phenomenological perspective, it is this anticipatory intentionality—rather than the reified content of angular momentum—that constitutes the normatively relevant core of expert experience.

The point of what I have just said is that the anticipatory structures of horizonal intentionality discussed in section 3 are obscured when the expert reinterprets her own experience as a direct encounter with angular momentum—that is, when she objectifies what is, phenomenologically, a lived, horizonally structured intentional relation. Given such an objectified self-report, the phenomenologist could either advocate neutrality in matters of interpretation, and take the scientist’s description at face value. However, if the phenomenology of science were to reduce to merely recording scientists’ self-reports without taking a stand on whether particular reports are actual descriptions of expert experience or objectivist construals of that experience, the phenomenology of science as a program would lack any normative punch. Worse still, the phenomenology of science would lose any connection to its traditional self-understanding as a critical corrective for metaphysical hypostatizations that are not grounded in, but rather imposed on, the realities of scientific practice.

Rather than advocating for interpretational neutrality in this manner, a phenomenologist might choose to completely dismiss the scientist’s self-report as an objective misinterpretation of their own experience. However, if the phenomenologist’s interpretive practice involves disregarding portions of the scientist’s self-reports, based on specific criteria determining what is or isn’t a valid description of expert experience, then the overall utility of qualitative methods in the phenomenology of science becomes somewhat dubious. An obvious issue with this approach is its *circularity*: The primary motivation for acknowledging scientists’ self-reports as a viable basis for phenomenological analyses of science was to sidestep preconceived notions of science that predominantly echo the biases of philosophers, rather than the actualities of scientific practice. However, if the methodological directive within the second stage of the phenomenological interview now advises selectively disregarding certain parts of scientists’ self-reports, then phenomenologists appear to be doing precisely what they initially sought to evade: They depend on preconceived notions of science to pinpoint those parts of scientists’ self-reports from which they hope to derive a conception of science that isn’t already tainted with preconceived notions of science.

Before considering a possible response to this challenge, it is important to clarify a potential misunderstanding: the concern raised here is not that phenomenologists reject interpretation as such. As discussed earlier in connection with horizonal intentionality, experience—scientific or otherwise—is inherently structured by anticipations that are shaped through prior familiarity and experience. What is at issue, then, is not whether interpretation plays a role in expert experience—it clearly does—but whether certain interpretitive frameworks (e.g., strongly objectivist ones) obscure, rather than disclose, the essential structures underlying experience. The methodological aim is therefore not “interpretational presuppositionlessness” in the strong sense, but a careful bracketing in favor of descriptions that remain accountable to the invariances of experience. In phenomenological terms, this means assessing the *eidetic adequacy* of a description—that is, whether it captures the essential features of the experience under investigation, rather than offering a merely idiosyncratic or theoretically overdetermined account.

With this clarification in mind, we can now consider a possible response to the problem of circularity—namely, to deny that it constitutes a problem at all. Specifically, one could argue that phenomenologists are justified in disregarding instances where the interviewee (scientist or otherwise) offers explanations rather than descriptions of their experience. For example, if interviewees talk about photons, biochemical pathways, or photoreceptor cones when asked about their experience of perceiving a lab workbench, the phenomenologist is not obligated to treat such reports as meaningful attempts to describe the interviewee’s actual lived experience. However, while this point might hold in somewhat simplistic cases like the one mentioned, more realistic scenarios where scientists discuss their expert experiences highlight that the issue cannot be so easily dismissed.

To understand why, consider my earlier example of a physicist who describes her experience of identifying the SU(2) symmetry group in a quantum model as a direct encounter with angular momentum. As previously argued, such a report could initially be taken to reflect a clear objectivist distortion, akin to confusing explanations involving photons, biochemical pathways, or photoreceptor cones with the actual experience of perceiving a lab workbench. However, on closer inspection, the situation is more complex than this. Shannon Vallor, drawing on earlier phenomenological work by Maurice Merleau-Ponty, Patrick Heelan, and others, argues that “[w]hen an experimenter can […] ‘read’ […] distinctive quantum numbers off the data produced by high-energy particle collisions, the pregnant signature of that particle becomes manifest to the experimenter in a *perceptual style*, which is why the experimenter so naturally speaks of having observed the particle” (2009, p. 15; my emphasis). The point of Vallor’s argument is that, in the case of successful encounters with unobservables such as quantum entities, these entities are perceived “in a manner isomorphic with ordinary perceptual judgments” (ibid., p. 13), thus turning the scientist’s report of a direct encounter with angular momentum *into* *a faithful report of expert experience*. This raises an obvious problem: Given the existence of competing phenomenological perspectives on the issue of scientific realism, how are we, as phenomenological interviewers, to determine whether scientists’ self-reports constitute a faithful description of experience or an unintended explanation? If making this distinction requires adopting a prior theoretical stance, then the incorporation of qualitative interviews as an extension of phenomenology’s descriptive methodology risks falling into the circularity problem I described earlier.

The problem I have just addressed can also be reframed as an issue regarding the descriptive character of phenomenology of science. Already in the *Logical Investigations*, Husserl emphasized that “theory of knowledge, properly described, is *no theory*” (Husserl, 2001, p. 178). According to Husserl, the issue with many existing epistemological approaches is that they are contanimated with pre-established theoretical assumptions from the very outset. For instance, when epistemologists ask how a self-enclosed subject can access the external world to acquire justified true beliefs about reality, this inherently assumes extensive presuppositions about the nature of knowledge and the relation between the supposed interiority of the mind and the alleged exteriority of the world. To prevent such presuppositions from pre-determining the outcome of our analyses, Husserl thus advocates for a descriptive methodology which requires us to stay as close to the “how” of experience as possible.

As I have mentioned in section one, phenomenology of science follows this methodological strategy. However, as I have also made clear in section three, the subject matter of this field presents unique challenges not typically encountered in epistemology or other philosophical areas. While it is reasonable to assume that most individuals have a basic familiarity with experiences of general epistemic relevance, the expert experience accompanying scientific practice is confined to those with the necessary skill and expertise. It is this inaccessibility of expert experience that necessitates the use of qualitative interview to broaden our “descriptive reach”: Given that the individual conducting the phenomenological analysis is typically not the one with expert experience, the material for our descriptive efforts must be gathered by interviewing experts.

When interviews are correctly categorized as extensions of our descriptive methodology, the problem I am hoping to address here becomes even more evident. While the adoption of a descriptive methodology aims to prevent our analyses from being contaminated by pre-conceived theoretical assumptions, we contradict our own objective by discarding parts of scientists’ self-reports on the basis of pre-established ideas of what what is or isn’t a valid description of expert experience.

At this point, a critic might once again charge me with exaggerating the issue. A counterpoint could be articulated as follows: While it is true that a descriptive methodology seeks to keep our analyses free from the influence of pre-existing theoretical assumptions, this doesn’t preclude us from selectively focusing on aspects of our descriptions that are relevant for whatever our theoretical objectives are. For instance, if we are interested in the essential structures that underlie the perceptual experience of everyday objects, our phenomenological analyses would begin with a detailed description of perceiving an everyday object, such as a coffee mug. However, employing a descriptive methodology in this manner does not imply an indiscriminate adherence to every facet of the perceptual episode. On the contrary, the ability to pinpoint, say, perspectival givenness as a structural characteristic of perceptual experience hinges on the capacity to discard elements of the perceptual episode deemed irrelevant to the pertinent structural feature. Yet, if we have the liberty to disregard elements of our descriptions in more conventional cases of phenomenological analysis, shouldn’t we be able to do the same when dealing with descriptive material collected through interviews?

The issue with this argument is that there can be a wide range of reasons for omitting elements of phenomenological descriptions, some of which are methodologically acceptable, while others are not. When one omits specific aspects of the perceptual experience of a coffee mug to highlight the structural characteristic of perspectival givenness, the differentiation between essential and non-essential features isn’t determined by a preconceived notion of what the perceptual experience of a physical object entails. Rather, it is the other way around: We identify perspectival givenness as a structural feature of perceptual experience because it remains invariant throughout the entire perceptual episode, suggesting itself as an essential component of our notion of physical thinghood (Berghofer & Wiltsche, 2019; Wiltsche, 2013). On the other hand, if we discard parts of scientists’ self-reports because we consider them to be objectivist misconstruals of actual expert experience, the problem is not only that this demarcation is imposed by someone who is not the one having the experience. The main issue is that the line between essential and inessential elements of the descriptive material is drawn based on *external* criteria instead of characteristics inherent to the descriptive material itself, thus undermining the very goal a descriptive methodology.

Let me anticipate one final line of criticism. A reader might object[[17]](#footnote-17) that the question of the validity of descriptions of experience has already been discussed extensively in the literature. In this debate, there is a general consensus that the “criteria [for determining validity] are not to be understood […] as pertaining to a ‘correspondence theory of truth’ between experience and its description” (Høffding & Martiny, 2016, p. 557). Instead, as Bitbol and Petitmengin put it, the “[v]alidity of a first person report is [rather] a validity ‘in action’, which cannot be measured in static terms of correspondence between the report and the experience, but in dynamic terms of performative consistency of the acts which produce it” (p. 400). Bitbol and Petitmengin explicitly compare the interview situation to data collection in astronomy or neuroscience, where researchers likewise rely on instruments to mediate access to their subject matter. The point of this analogy is to underscore that, even in the natural sciences, we do not achieve direct cognitive access to the object of inquiry. What we rely on instead is reproducibility and the sustained coherence between data, instruments, and theoretical frameworks. In our context, this means that rather than aiming for the elusive ideal of an “undistorted expert experience”, we should orient ouselves toward “validity in action” and “performative consistency” (see also Martiny et al., 2021, p. 14).

While this line of reasoning may be compelling in some contexts, I would argue that adopting “validity in action” as the sole epistemic standard would undercut the normative aspirations of the phenomenology of science. The reason is straightforward: if what counts as valid phenomenological description is judged only by coherence and consistency, then even deeply objectivist construals of experience would qualify as legitimate. After all, objectivism itself has long exhibited precisely this kind of internal consistency and cross-contextual reproducibility that this account of validity requires. Following Husserl’s argument in the *Crisis*, objectivism is not merely a local misunderstanding but a powerful intellectual tradition with deep historical roots and high performative stability within large parts of scientific culture. If the methodological filter applied to interview material cannot distinguish between such objectivist sedimentation and phenomenologically grounded descriptions, then we lose the ability to identify precisely those distortions that the phenomenological approach is meant to reveal. Seen from this perspective, fidelity to “validity in action” threatens to dissolve the critical and normative edge of phenomenology of science, especially insofar as it aspires to clarify the pre-theoretical conditions of scientific practice. What is at stake, then, is not the rejection of coherence as such, but the recognition that not all norms of coherence are equally revealing of the structures phenomenology is uniquely equipped to analyze.

Let me summarize the results of this and the preceding section. Following Høffding’s and Martiny’s proposal, the two tiers of the phenomenological interview are ideally structured to allow for a clear separation between a descriptive first phase—during which interview “data” is generated—and a normative second phase, in which the phenomenologist engages in interpretation and the identification of “invariant structures” (Martiny et al., 2021, p. 3; see also Zahavi & Martiny, 2019). However, if my arguments are correct, the phenomenology of science encounters difficulties in both phases. The challenge in the descriptive phase lies in the fact that scientists are particularly prone to objectivist distortions of their lived experience, owing to the nature of their practice and their immersion into the scientific worldview. The interpretive phase presents a different, but related difficulty: the distinction between legitimate parts of scientists’ self-reports and those that qualify as objectivist distortions relies on normative criteria that phenomenology of science itself is supposed to generate. Yet, if interviews are meant to extend the “descriptive grasp” of phenomenology of science, relying on pre-established normative assumptions during the interview process seems to undermine the very purpose of phenomenology of science—namely, to approach scientific experience without pre-established notions of what science is or ought to be. This problem is particularly acute in the context of science, where the objects of expert experience—such as force fields, quarks, and quantum systems—aren’t intutively given in the way as everyday objects like coffee cups, blossoming trees, or hammers are.

1. Concluding Remarks

Assuming that my previous arguments are valid, we face a significant methodological conundrum in the phenomenology of science. On the one hand, phenomenologists find themselves reliant on expanding their descriptive methodology via qualitative interviews, a necessity born from the inherent inaccessibility of expert experience. On the other hand, the descriptive material collected through interviews is often shaped by theoretically induced construals of experience, which may limit its utility for phenomenological analyses. Any attempt to selectively discards certain elements from the descriptive material appears to contradict the original intent behind adopting a descriptive methodology, which was to prevent preconceived notions of science from influencing the results of our analyses.

However, it’s crucial to clarify the extent of my argument. While I firmly believe that the challenge posed by expert experience warrants serious consideration from phenomenologists of science, I do not view it as an insurmountable obstacle. Do I think that the majority of existing phenomenological analyses of science are overly abstract and lack sufficient attention to actual descriptions of scientific practice? Undoubtedly, yes. Do I maintain that, even if phenomenological analyses were to focus more on descriptions of scientific practice, the methodological arsenal of the phenomenology of science would need to incorporate qualitative interviews to truly access the realm of expert experience? Again, the answer is an unequivocal yes. Would a more systematic employment of qualitative interviews give rise to the issues that I have endeavored to address in the preceding sections? Once more, the answer is yes. However, in my perspective, the only viable approach to these challenges is to, first, evaluate the specific uses of qualitative methods on a case-by-case basis, to, second, be more forthright about the overarching issue of methodology, and, third, to think more about the sociological settings in which phenomenology of science should be done in the future. I would like to wrap up this paper with some final thoughts on these points.

In his programmatic article *Philosophy as Rigorous Science*, Husserl criticizes his own discipline philosophy in severe and uncrompomising words. “During no period of its development,” Husserl writes, “has philosophy been capable of living up to [its] claim of being rigorous science. […] I do not say that philosophy is an imperfect science; I say simply that it is not yet a science at all, that as science it has not yet begun” (Husserl, 1965, pp. 71–73). What Husserl reproaches the philosophical tradition that preceded him for is its total disregard for the methodological question of how philosophy should, in fact, be done. “One cannot learn philosophy,” Husserl complains, “because […] here the problems, methods, and theories have not been clearly defined conceptually, their sense has not been clarified fully” (Husserl, 1965, p. 73). In response to this fundamental issue, Husserl devoted much of his energy to methodological concerns. His advocacy for a descriptive methodology, along with the introduction of phenomenological reduction and epoché, should be viewed as efforts to provide philosophy with something it desperately needs: a methodological approach that can be communicated, discussed, criticized, and, if necessary, modified.

My article is written in this very spirit. For the phenomenology of science to meet Husserl’s high ideals and secure a unique position in contemporary philosophy of science, it is essential to directly address what the methods of phenomenology are and how they can be applied to elucidate scientific practice. With regard to these questions, much can be learned from other areas of applied phenomenology where the integration of various methodological tools has already a longer tradition than in the relatively new field of phenomenology of science. For this reason, it’s crucial that the phenomenology of science avoids the pitfall of interacting solely with “mainstream” philosophy of science and the special sciences. In terms of methodology, other areas could potentially offer more intriguing insights, despite their subject matters appearing to be more distant.[[18]](#footnote-18)

However, no matter how much emphasis we place on methodological discussions, their utility will always be limited. This is not just a reflection of the nature of methods themselves but also of the layered and intricate character of the “data” we can expect to obtain through interviews. As I have highlighted repeatedly in this paper, a key tenet of the phenomenology of science is that the knowledge presented in standard science textbooks constitutes only part of what is necessary for genuine scientific practice. Textbooks typically focus on the formalized, easily codifiable operations required to manipulate theoretical symbols in a quasi-algorithmic way. Yet applying these theories and models to concrete empirical scenarios calls for skills that transcend the comparatively narrow domain of traditional “knowing-that.” The situation is similar when considering interview-based research. Even if we recognize the importance of thorough methodological discussions regarding the use of interviews—and even if interviewers rigorously adhere to the guidelines derived from these discussions—the evaluation of both the interview “data” and the interpretations drawn from it can never occur in isolation. Such evaluation must remain tied to the specific interview material itself. This is due in part to the layered and multifaceted nature of the experiences reported through this material. Returning to an earlier example: while intending a model directly through the mathematical symbols on a whiteboard and “looking through” the same model to reconstitute an experimental setup on a lab workbench might seem like routine applications of models in scientific research, it is only through careful attention to the underlying experiential structures that the differing roles of models in these scenarios become evident. Appreciating these differences relies not only on the methodological rigor applied to the interviews but also on acknowledging the concrete circumstances of both the initial experience and the interview through which we access that experience.

I want to conclude with a reflection on the potential significance of social settings for research in the phenomenology of science—a topic that, to the best of my knowledge, has yet to be addressed. While phenomenologists of science have been notably successful in collaborating with representatives from specific disciplines like physics (Berghofer et al., 2020, 2023; Berghofer & Wiltsche, 2023b), there has been little to no attention given to the social spaces where these collaborations unfold. I believe this is a mistake, particularly if we aim to incorporate qualitative methods, specifically interviews, into the toolkit of the phenomenology of science. To provide a concrete example from my own work: In the autumn of 2024, a theoretical physicist visited my department for two months. During this time, we held several work meetings each week, during which I received an in-depth explanation of how the quantum symmetrization postulate is applied in specific cases and how it connects to empirical situations such as cloud chamber experiments (see Fig. 1 for the whiteboard after one of our work meetings). While the project we were working on did not explicitly involve interviews, the experience of such intensive and sustained interaction with a scientist over an extended period convinces me that this type of setting could serve as the ideal preparation for conducting the kinds of interviews needed for phenomenology of science. What I gained from this extended personal exchange—and what I believe would be invaluable for preparing a suitable interview setting—is a more holistic understanding of the *entire* perspective from which a scientist approaches their subject, a perspective that extends far beyond the technicalities of the respective science. Of crucial importance for gaining this understanding was also the dialogical nature of our exchange. The ability to ask questions and A white board with writing on it

AI-generated content may be incorrect.engage in a continuous back-and-forth between my perspective and that of my guest was crucial for arriving at a deeper, more comprehensive understanding of the research problems.[[19]](#footnote-19)

Figure . Whiteboard after one the meetings with the theoretical physicist who was visiting my department for two months in the autumn of 2024.

To be sure, the intensive nature of our interactions would raise methodological questions of its own. For instance, in sociology of science and STS, engagement with scientists often follows the ethnomethodological tradition of studying laboratory life without intentionally engaging in direct engagements with the studied scientists. The aim of such studies is to analyze “how scientific discoveries and mathematical proofs are produced and ‘extracted’ from the disciplinary-specific *Lebenswelt* of the laboratory project or the mathematics lesson” (Lynch, 1994, p. 114). While this approach offers the advantage of greater impartiality and neutrality toward the scientists being studied, I remain skeptical that it would yield the kind of “data” necessary for a more robust phenomenological understanding of, for instance, how mathematical models function in scientists’ constitution of experimental setups. The problem, as I argued earlier, is that scientists without any familiarity with phenomenology are unlikely to provide the type of detailed description of modeling experience I outlined in Section 3. Given this, it is difficult to see how merely observing scientists without directly engaging with them would address this issue in any meaningful way.

A more fruitful resource from sociology of science and STS comes from Harry Collins’s notion of *interactional expertise*, developed in his later work (Collins & Evans, 2009).[[20]](#footnote-20) Unlike ethnomethodological approaches, which tend to bracket normative questions, Collins’s framework offers conceptual resources that can be directly integrated into the phenomenological method proposed here. According to Collins, interactional expertise is the ability to master the language and conceptual practices of a specialist domain through prolonged immersion and dialogue, even without engaging in its practical activities. In the present context, the kind of “intensive and sustained interaction” with scientists discussed above can be seen as cultivating precisely this kind of expertise. Such interactional familiarity does not aim at performative mastery, but at an informed sensitivity to the internal structure and horizon of expert experience. This, in turn, equips the interviewer with the fluency necessary to assess whether interviewee descriptions remain faithful to the anticipatory, embodied, and sense-giving structures at stake. From this perspective, interactional expertise serves as an important enabling condition for achieving eidetic adequacy in second-tier evaluation of qualitative interviews. Thus understood, interactional expertise might offer a solution to the challenge of expert experience: If the phenomenologist possesses interactional expertise in Collins’s sense, she need not be a full-fledged expert (i.e., possess contributory expertise) to competently engage expert discourse in interview situations, discern the domain’s essential experiential structures, and, most importantly, assess the eidetic plausibility of first-person descriptions in a philosophically responsible manner.

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1. Whether the original Heideggerian position—or positions derived from it—must be adversarial toward science is an open question that cannot be settled here. What can be said, however, is that the relationship between Husserl and Heidegger—both personally and philosophically—is complex, especially in regard to their respective engagements with science. While Husserl’s *Crisis* can be read as a response to themes raised by Heidegger, their treatments of these issues diverge markedly. Husserl’s approach remains rooted in a normative project, whereas Heidegger’s critique of scientific abstraction emerges from a more ontological and historicized analysis. As will become clear below, the present account aligns more closely with the Husserlian tradition. [↑](#footnote-ref-1)
2. One of the most striking examples is the scientific realism debate, which has played a significant role in the phenomenology of science for several years. While there is now broad agreement that phenomenology “will not fit neatly into the space defined by the axes of the [standard] realism-antirealism debate” (French, 2020, p. 217), many phenomenologists have nevertheless positioned themselves in relation to existing analytic positions. This is evident in their partial alignment with stances such as van Fraassen’s constructive empiricism (Wiltsche, 2012), Hacking’s entity realism (Vallor, 2009), perspectival realism (Khalili 2022) or more robust forms of theory realism (Hardy, 2014). [↑](#footnote-ref-2)
3. While it may seem obvious to many that scientific practice—rather than an idealized notion of science—is the primary subject matter of the phenomenology of science, some may still seek an explicit argument supporting this view. To the best of my knowledge, one of the most thorough attempts to argue that phenomenology is fundamentally a philosophy of scientific practice—and that even Husserl himself, despite his transcendental perspective, adhered to this ideal—can be found in the work of Mirja Hartimo (2021). Although her focus is specifically on Husserl’s relationship to mathematics, her argument remains broadly applicable to the sciences as a whole. [↑](#footnote-ref-3)
4. It would take me too far afield to elaborate on the details, but a concrete example of this issue can be found in the foundations of quantum mechanics. Efforts to interpret the formalism of quantum mechanics have long been troubled by several paradoxes, such as the measurement problem (“Why does a quantum system, which evolves deterministically as a superposition of all possible states, collapse to a single definite outcome upon measurement?”) or observer-dependence (“Why does it appear that the outcome of a quantum measurement depends on the presence of an observer, and where do we draw the boundary between the quantum and classical realms?”). Bohmian mechanics offers one interpretational framework that introduces “hidden” deterministic particle trajectories into the standard formalism to address these paradoxes and align quantum mechanics with a more “classical” ontology of particles and trajectories. However, because this theoretical modification is driven by philosophical rather than internal theoretical or empirical considerations, it has been argued that Bohmian mechanics conflicts with the “physics first” approach which characterizes phenomenological perspectives on physics (Berghofer & Wiltsche, 2023a, pp. 9–11). See, for a general introduction to this topic, Lewis (2016). [↑](#footnote-ref-4)
5. I cannot go into detail here, but there are additional differences that distinguish phenomenology from recent attempts to integrate qualitative methods into “mainstream” philosophy of science. Broadly speaking, much of the debate in standard philosophy of science is driven by the question of how *data* from particular or concrete cases can be used to generate more general or abstract conclusions about topics such as the representational practices or epistemic values operative in different disciplines (Nersessian & MacLeod, 2022; Wagenknecht & Mansnerus, 2015). However, as will become clearer below, the central issue in this paper is not primarily one of *inference* but rather of *access* to first-personal descriptions of expert experience. This is not to say that questions of inference are irrelevant to the phenomenology of science. However, since they are secondary to the issue of successful access to lived experience, a full treatment of their role must be left for another occasion. [↑](#footnote-ref-5)
6. It is worth noting that even within phenomenology itself, the picture is more complex. In addition to the existential branch mentioned earlier, there is also a post-structuralist strand—represented by thinkers such as Dimitri Ginev (2016), Hans-Jörg Rheinberger (2023), or Joseph Rouse (1996)—which emphasizes the discursive and contingent dimensions of scientific knowledge. While these authors have made important contributions to contextualizing scientific practice, they tend to downplay—or outright reject—the notion of a phenomenological method capable of yielding normative insights into essential structures underlying expert experience. It is in this sense that their approaches differ from the one proposed here. [↑](#footnote-ref-6)
7. The example of the constitution of electromagnetic fields is a modification of a case study discussed by the phenomenologically inspired mathematician and theoretical physicist Hermann Weyl (2016). [↑](#footnote-ref-7)
8. “Noema” is a technical term in Husserlian phenomenology that refers to the *object-as-intended*. While a detailed explanation goes beyond the scope of this discussion, a simple example can offer an initial—though admittedly superficial—understanding: consider two people intending Venus as the “morning star” and the “evening star”. Although both refer to the same physical object, they do so through different meanings, each carrying distinct associations and anticipations. For a comprehensive discussion of the concept of “noema”, see (Smith, 2006). [↑](#footnote-ref-8)
9. As one anonymous reviewer pointed out, the distinction between these two modes of model-engagement may be seen to parallel the Heideggerian distinction between the “ready-to-hand” and the “present-at-hand” (Glazebrook, 2000; Goldberg, 2024) or its Dreyfusian rendering as the “available” and the “occurrent” (Dreyfus, 1990). While this analogy is certainly illuminating, it does not fully map onto the framework developed here. The key point in my analysis is that both modes of model engagement—the model as a straightforward intentional object, and the model as a background lens structuring practical activity—are part of scientific practice itself. The transition between them is not necessarily tied to a move from practical involvement to reflective detachment, but can take place fluidly within the activity of research. Moreover, these two modes of model-engagement entail distinct experiential structures, and the challenges for phenomenological interviewing, then, is to find ways of articulating both kinds of experience. [↑](#footnote-ref-9)
10. There are of course notable exceptions such as Hermann Weyl or Fritz London. However, it seems safe to say that this the exception rather than the rule. [↑](#footnote-ref-10)
11. This problem frequently arises in discussions about the foundations of quantum mechanics. A typical example is the standard treatment of many-particle systems, where particles are assigned distinct labels. Yet this practice presupposes that quantum mechanics deals with individuable entities—an assumption that, upon closer examination, is difficult to justify on physical grounds. It has been argued that this problem is merely “a symptom of a prior metaphysical prejudice about the nature of physical objects, a prejudice which, embodied in the labels, congeals in the theory and then sustains seemingly irresolvable conflicts with our classical intuitions interacting with other aspects of the theory” (Redhead & Teller, 1991, pp. 43–44). [↑](#footnote-ref-11)
12. My argument here, of course, rests on the assumption that what I perceive as an objectivist *presupposition* is ineed a mere presupposition. Since a full discussion of the available phenomenological arguments against objectivism would take us too far afield—and given that a critical stance toward objectivism is a defining feature of phenomenology—I will simply pressupose that objectivism, understood as the view that a neutral perspective on reality is possible, independent of constituting consciousness, is incorrect. For a discussion of the concept of objectivism and its relationship to related notions such as naturalism, realism and psychologism, see Dorfman (2013). For an overview of key phenomenological arguments against objectivism, see Zahavi (2017). A second issue should be noted in this context. Even for those sympathetic to my critique of objectivism, one might—as an anonymous reviewer did—raise the concern that I risk replacing one form of metaphysics—objectivism—with another: namely, a strong essentialism that posits invariant structures of experience as universal and independent of individual subjects. To defend the version of phenomenology of science I am proposing against this charge would require a broader defense of the entire project of a transcendentally oriented phenomenology of science—a task which, as noted in Section 1, lies beyond the scope of this paper. What I can do here is refer the reader to footnote 14, where I elaborate on the kind of transcendentalism I am committed to, and to the following works, which broadly align with the overall vision of a defensible phenomenology of science: (Berghofer, 2022; French, 2023; Hardy, 2014; Islami & Wiltsche, 2020; Trizio, 2020). [↑](#footnote-ref-12)
13. Høffding and Martiny have published a paper in which the seem to explicitly deal with some of the problems I am addressing here (Høffding et al., 2022). For instance, they discuss what the call the “ontological objection”, the “categorial problem for people knowing the cognitive, psychological and biological underpinnings of their experience” (Høffding et al., 2022, p. 42). On closer inspection, however, their problem is not one of scientists reinterpreting their own experience in the light of scientific meta-narratives. Høffding’s and Martiny’s problem is rather the “naturalistic bias attributing more importance to biology, (neuro)psychology, and (unconscious) cognition than to experience)” (Høffding et al., 2022, p. 42). Or, to put it differently: The issue Høffding and Martiny focus on is the rejection of qualitative interviews altogether, based on the claim that the experiential level targeted by such interviews is explanatorily irrelevant. However, this is not the problem I am addressing here. My concern is the distortion of interview “data” caused by the naturalistic and objectivistic biases of the interviewee. Similarly, while the other problems discussed by Høffding and Martiny are interesting, they are not the ones I am focusing on here. [↑](#footnote-ref-13)
14. The example Petitmengin uses to describe such a training exercise is to ask the interviewee to recall a vacation and to describe the visual, auditive, kinesthetic, emotional, olfactory and gustatory dimensions of the memory. [↑](#footnote-ref-14)
15. One anonymous reviewer raised the question as to whether one strategy to avoid the descriptive fallacy might be to incorporate third-person data sources, such as brain imaging, in line with the idea of a “phenomenological mixed method” (Martiny et al., 2021). While I cannot rule out the possibility that this could be a viable approach, I must admit that I struggle to envision study design that would be practically implementable in a typical research context relevant to the phenomenology of science. Another reviewer expressed concern that the method might implicitly rely on an individualist epistemology, given the use of first-person singular reports. While in many cases interviews focus on individual cases for practical reasons, the method is in principle open to first-person plural articulations, and the goal is to identify intersubjectively shared, eidetic structures—not idiosyncratic subjectivity. See, for a general discussion of the relevance of the intersubjective dimension not only of phenomenological interviews, but phenomenology of science more generally, (Wiltsche, 2018). [↑](#footnote-ref-15)
16. One anonymous referee encouraged me to clarify the extent to which I align myself with Varela’s and Shear’s “interpretivism.” While a full response would take me too far afield, my short answer is as follows: Drawing on a broadly transcendental perspective in the spirit of the later Husserl, I would argue that the hermeneutic claim—that all experiencing is sense-making and therefore fully interpretative—is valid within the natural attitude, and thus also within the domain of science. However, the sense-making characteristic of the natural attitude depends on deeper, underlying transcendental structures that must already be in place for such interpretive activity to occur. Ultimately, it is these transcendental structures—understood as invariances, such as the horizonal structure discussed in Section 2—that phenomenological analysis seeks to uncover. It is from this level that the phenomenology of science derives its normative force. [↑](#footnote-ref-16)
17. Just as one anonymous reviewer did. [↑](#footnote-ref-17)
18. For instance, interesting phenomenological work has been done on empathy as the precondition for the acquisition of embodied skills (Gieser, 2008). Although these considerations neither concern the role of qualitative interviews nor scientific practice, important methodological lessons can be drawn from the existing studies of embodies skills and expertise. [↑](#footnote-ref-18)
19. One might describe the dynamic of this back and forth as structurally akin to a hermeneutic circle—where preliminary understandings are recursively revised and refined through ongoing interaction with the phenomena under investigation. While hermeneutic philosophy treats this circularity not as a flaw but as a constitutive condition of meaning-making, the process described here aligns with that view to the extent that it involves an iterative sharpening of descriptive insight. The aim is not to overcome circularity, but to engage it reflectively, allowing for a progressive clarification of the experiential structures in question. See, for a discussion of hermeneutic circularity in philosophy of science, (Kochan, 2015). [↑](#footnote-ref-19)
20. I am indebted to an anonymous reviewer for pointing me to Collins’s notion of interactional expertise, which has significantly informed the present account. [↑](#footnote-ref-20)