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The benefits of acquiring interactional expertise: Why (some) philosophers of science should engage scientific communities

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ABSTRACT

Philosophers of science are increasingly arguing for and addressing the need to do work that is socially and scientifically engaged. However, we currently lack well-developed frameworks for thinking about how we should engage other expert communities and what the epistemic benefits are of doing so. In this paper, I draw on Collins and Evans' concept of 'interactional expertise' – the ability to speak the language of a discipline in the absence of an ability to practice – to consider the epistemic benefits that can arise when philosophers engage scientific communities. As Collins and Evans argue, becoming an interactional expert requires that one 'hang out' with members of the relevant expert community in order to learn crucial tacit knowledge needed to speak the language. Building on this work, I argue that acquiring interactional expertise not only leads to linguistic fluency, but it also confers several 'socio-epistemic' benefits such as the opportunity to cultivate trust with scientific communities. These benefits can improve philosophical work *and* facilitate the broader uptake of philosophers' ideas, enabling philosophers to meet a variety of epistemic goals. As a result, having at least some philosophers of science acquire interactional expertise via engagement will likely enhance the diversity of epistemic capacities for philosophy of science as a whole. For some philosophers of science, moreover, the socio-epistemic benefits identified here may be *more* important than the ability to speak the language of a discipline, suggesting the need for a broader analysis of interactional expertise, which this paper also advances.

1. Introduction

The past few years have seen increasing discourse on the relationship between philosophy of science and scientific domains, especially regarding the need for more attention to scientific practice, engagement with scientists, and impact on scientific research and its applications (e.g., Fehr & Plaisance, 2010; Frodeman & Briggle, 2016; Plaisance, Michaud, & McLevey, 2020; Waters, 2019). As others have demonstrated, engaging with scientific communities (or science policymakers) can shed light on traditional philosophical issues and generate new philosophical questions, thus serving as a philosophically fruitful endeavor (Douglas, 2010; Tuana, 2010). While much of this work does an excellent job motivating the need for more engaged approaches, little of it considers how philosophers of science acquire scientific knowledge or position themselves to influence scientific communities in the first place. For example: Is engagement with scientists necessary for developing an accurate understanding of science, or is reading scientific textbooks and journal articles sufficient? What role does engagement play in enhancing one's philosophical work or increasing its uptake? What are the potential downsides of engagement?

In this paper, I address each of these questions by drawing on a well-developed framework for scientific expertise called 'Studies of Experience and Expertise' (SEE), spearheaded by sociologists of science Harry Collins and Robert Evans. One of the key contributions of SEE is the development of a concept called 'interactional expertise', which captures the ability to speak the language of a discipline without the corresponding ability to practice (Collins & Evans, 2007). As Collins and Evans argue, interactional expertise can only be acquired through *immersion* in a community of experts as linguistic fluency requires tacit knowledge that is not codified in texts. Many philosophers of science would likely qualify as interactional experts on Collins and Evans' view, having spent significant amounts of time interacting with scientists and acquiring important tacit knowledge in the process. This tacit knowledge can be important for achieving particular philosophical aims – for instance, by giving philosophers access to unwritten information that increases the descriptive adequacy of their accounts. Immersion can also enhance philosophers' understanding of the sociological aspects of science, which Helen Longino and others have argued is important for

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particular types of epistemological analyses (Longino, 1990; 2002). This is indeed one of the reasons for the 'turn to practice' seen in much philosophical work (and in the growth of organizations like the Society for Philosophy of Science in Practice). Thus, the concept of interactional expertise – and the process of immersion required to obtain it – can be helpful in understanding how some philosophers of science can and do acquire scientific knowledge, and how that knowledge contributes to their philosophical work. While not all philosophers of science should strive to become interactional experts – both because not all work in philosophy of science is relevant to scientific practice and because some philosophers may want to maintain "critical distance" – it is beneficial to have at least some philosophers of science develop this type of expertise.

In the process of applying Collins and Evans' framework to philosophy of science, I also argue that there are additional benefits to immersion that Collins and Evans underemphasize or even overlook. While they primarily focus on the linguistic fluency that immersion brings, I highlight what I call the 'socio-epistemic' benefits of immersion. These include, among other things, understanding what motivates scientists and other experts, cultivating trust with expert communities, and identifying potential allies in a scientific field. Such socio-epistemic benefits not only aid philosophers of science (and interactional experts more generally) in understanding how scientific knowledge is generated, but they can also increase one's capacity for having an impact on scientists' thinking and practice, perhaps even advancing scientific research or its applications. (In fact, these socio-epistemic benefits may be more important than linguistic fluency for some aspiring interactional experts.) Interestingly, having an impact on science is a goal that many philosophers of science believe is essential to the discipline (Plaisance, Graham, McLevey, & Michaud, 2019). Some have even argued that philosophy of science, as a discipline, has an *obligation* to ensure its work has broader impacts (Cartieri & Potochnik, 2014; Fehr & Plaisance, 2010; Shrader-Frechette, 2007). By having some philosophers of science acquire interactional expertise in scientific domains, we can increase the epistemic capacity of our field, diversifying not just what we *know* but what we can *do* with that knowledge. As such, this paper should be of interest to many philosophers of science, regardless of their individual goals or approaches.

This paper has two overarching aims. The first is to use the concept of interactional expertise as a framework for thinking about how philosophers of science acquire scientifically-relevant expertise and what benefits arise from immersing oneself in an expert community. Thus, this paper contributes to a social epistemology of philosophy of science, analyzing how philosophers of science come to know things about science, how interacting with other experts generates new knowledge, and how philosophical knowledge can cross disciplinary boundaries. The concept of interactional expertise can also play a legitimizing role regarding the scientifically-relevant expertise that many philosophers of science have (thus making it a helpful concept for philosophers of science to employ). In my own experience, I have found that many people outside philosophy are unaware that philosophy of science exists as a field; hence, having additional ways of characterizing the nature of our expertise and our epistemic capabilities can improve the chance that philosophers of science will be recognized as having relevant knowledge and skills with respect to scientific research and its applications (both as critics and as potential contributors). The second aim of this paper is to contribute to the development of the concept of interactional expertise itself (and the larger SEE framework) by identifying additional benefits of acquiring interactional expertise that have been underemphasized or overlooked. In particular, I demonstrate how the socio-epistemic benefits of immersion can facilitate the ability of interactional experts to contribute to other fields. Thus, this paper should be of interest to sociologists and philosophers who study the nature of expertise and/or the flow of knowledge across disciplinary boundaries.

I begin in the next section by giving a detailed account of interactional expertise and its development (section 2). I then explicate what I call the 'socio-epistemic' benefits of interactional expertise (section 3). Next, I lay out the benefits of acquiring interactional expertise for philosophers of science and why those benefits are important for achieving our goals. As I argue, there may be cases where the socio-epistemic benefits are actually more important than the linguistic fluency that comes with interactional expertise (section 4). To demonstrate these benefits, I draw on case studies as well as empirical research on the goals, views, and experiences of philosophers of science regarding broadly engaged work (Plaisance et al., 2019). I also consider some of the downsides to immersion, including concerns about the loss of critical distance that may be important for some types of philosophical work (section 5). Finally, I review the broader implications of my argument for philosophy of science as a discipline, emphasizing the benefits of increasing the diversity of our epistemic capacities (section 6).

2. What is interactional expertise and how is it acquired?

In 2002, Collins and Evans called for a 'third wave' of science studies – *Studies of Experience and Expertise* (SEE) – to address the question of who should be involved in technical decision making, that is, "decision making at those points where science and technology intersect with the political domain because the issues are of visible relevance to the public" (2002, p. 236). Their aim was to find a middle ground between the 'problem of legitimacy', where only a narrow range of individuals are seen as experts, and the 'problem of extension', where democratic aims essentially dissolve the expert/non-expert dichotomy. To achieve this goal, they introduced the concept of interactional expertise. Collins and Evans initially defined interactional expertise as "enough expertise to interact interestingly with participants and carry out a sociological analysis," which they contrasted with contributory expertise, "the ability to contribute to the science of the field being analyzed" (2002, p. 254). (As I explain below, they later changed the definition of interactional expertise to focus on linguistic ability.)

Interactional expertise (or 'IE') captures the scientifically-relevant expertise that some non-scientists hold, which Collins and Evans think should qualify someone as a legitimate contributor to technical decision making.[1] Collins and Evans later redefine IE as "expertise in the *language* of a specialism in the absence of expertise in its *practice*" (2007, p. 28). They also advance what they call the 'strong interactional hypothesis': namely, that when talking to contributory experts, IEs would be able to "pass" as contributory experts themselves (even though they would not be "let loose in the lab"). This sets a higher bar for IE than their earlier work, essentially operationalizing IE in terms of an ability to pass. Elsewhere, I have criticized this aspect of Collins and Evans work – and the notion of passing itself – arguing that a broader conception of IE would allow Collins and Evans to maintain the middle ground they seek by identifying those with relevant expertise while avoiding the exclusion that may happen if sounding like a contributory expert were a requirement (Plaisance & Kennedy, 2014). Despite this critique, I believe the concept of interactional expertise is an incredibly useful one, and a key contribution to both the study of expertise and issues of scientific and technical decision-making. For the purposes of this paper, it is not essential to determine where exactly the minimum threshold is or should be to consider someone an interactional expert. Rather, the focus of this paper is on the benefits that arise from *immersion* in a community of experts (a key requirement for IE). These benefits include both the linguistic fluency that Collins and Evans identify as well as the socio-epistemic benefits that I argue can facilitate the uptake of an interactional expert's ideas.

Collins and Evans flesh out the broader SEE framework in their (2007) book, *Rethinking Expertise*. They develop a Periodic Table of

[1] While the concept of interactional expertise is helpful for identifying those who should be included in technical decision making, I don't think it should be a strict *requirement* for such inclusion, as I argue elsewhere (Plaisance & Kennedy, 2014).

Expertise, ranging from low-level 'tidbits' of scientific knowledge to full-fledged scientific expertise. At the bottom is 'beer-mat knowledge': decontextualized information that we might classify as simple scientific 'facts' (e.g., that free-falling objects accelerate toward Earth at a rate of 9.8 m/s^2). At the next level is 'popular understanding', typically acquired through reading popular science books or magazines. This involves a richer understanding of scientific findings, though often without the qualifiers and nuances that are reported in peer-reviewed publications. Next is 'primary source knowledge', where one has familiarity with particular scientific methods and results, often by reading peer-reviewed journal articles in a scientific field. Notably, all three levels can be achieved through reading alone. The top two levels, which Collins and Evans refer to as 'specialist' expertise, require tacit understanding of the language and/or practices of a discipline. Interactional expertise is the linguistic ability one acquires by "hanging out" with relevant experts for a sustained period of time (Collins and Evans don't specify how long it takes, but it seems to be on the order of months, if not years, depending on how technical the target field is). Contributory expertise – the highest level – includes both linguistic and practical abilities such that one could contribute new knowledge to the field.[2] (As I discuss below, I think a non-trivial proportion of interactional experts have the potential to contribute.)

One of the key requirements for obtaining interactional expertise is immersion in a community of experts.[3] Collins and Evans contend that it is not sufficient to rely on written texts (e.g., textbooks and journal articles) to gain this level of expertise – though one can acquire a more advanced understanding of a discipline with such an approach. To fully grasp a language, and speak it with some fluency, Collins and Evans argue that one must be exposed to the *use* of the words that comprise it, for "it is the use of a concept that establishes its meaning, rather than any kind of logical analysis or dictionary definition" (2007, p. 23). Second, Collins and Evans argue that part of understanding a scientific discipline comes from being exposed to tacit knowledge. As they put it, "the language of a domain, like any spoken language, consists of more than propositional knowledge" (2007, p. 29). Thus, "'enculturation' is the only way to master an expertise which is deeply laden with tacit knowledge because it is only through common practice with others that the rules that cannot be written down can come to be understood" (2007, p. 24). Tacit norms of science, such as what methods are preferred and how outliers in data are handled, can be important for understanding how scientific knowledge is generated. These are often learned in graduate school through an apprenticeship model of education and are not always codified in textbooks or other written documents.[4] For those not already trained in a particular scientific field, immersion is essential for understanding these norms.[5]

It is important to note that the concept of interactional expertise was originally developed based on Collins' own experiences as a sociologist of science. After spending several years immersed in a community of gravitational wave physicists, Collins found that he had learned enough of the language to converse with the physicists – so much so that he could "sound like them" – but was never able to conduct experiments or contribute new knowledge to that field. (For a more detailed account of Collins' experiences, see Collins, 2019, chapter 4.) Not surprisingly, then, Collins and Evans assert that "the analyst who has even the highest levels of interactional expertise may be able to *understand* scientific things, and to *discuss* scientific things, but is not able to *do* scientific things (2007, p. 35).

Elsewhere, I have argued that at least some IEs would be able to contribute significant ideas and theories to scientific fields, whom we might refer to as 'contributing interactional experts' (Plaisance & Kennedy, 2014).[6] Collins and Evans have since changed their view on this, noting that IEs may be able to contribute more often than they initially thought (Collins & Evans, 2015). One of the reasons for our initial disagreement over this issue likely relates to our respective disciplinary positions. As a sociologist, Collins' primary focus is on understanding the *social* life of a scientific community. Philosophers of science, however, tend to focus on the *epistemological* aspects of science – e.g., by analyzing scientific concepts, methods, assumptions, and inferences – which can overlap significantly with scientists' own work (though philosophers should also attend to the social aspects of science, as I emphasize below). A second difference between Collins and myself is the area of science with which we engage. Gravitational wave physics is a highly technical field, which makes it difficult for those not formally trained in the field – and highly skilled at mathematics – to fully comprehend its practice. I, on the other hand, tend to engage with scientists in less technical fields that have a smaller learning curve. The philosophical work I do focuses on conceptual and methodological issues in these fields, which have clear implications for how scientists conduct their research and interpret their findings.

As I argue below, not only is it possible for IEs to contribute to the development of scientific fields, but it is immersion itself that largely facilitates contribution. Prolonged engagement with expert communities exposes aspiring IEs to the tacit knowledge Collins and Evans highlight and cultivates other useful knowledge about the community. This, in turn, can enhance an interactional expert's credibility, which can facilitate the uptake of their ideas among contributory experts.

3. The benefits of immersion

As discussed above, immersion is necessary for acquiring key tacit knowledge within a particular field. Tacit knowledge, by definition, includes knowledge that cannot be easily transmitted or codified in

[2] Unlike interactional experts, contributory experts also have 'embodied knowledge'. This concept "parallels what Gilbert Ryle calls 'knowing how': the series of actions and skills involved in the material realization of an experiment" (Leonelli, 2016, p. 95).

[3] In Collins and Evans' more recent work, they stipulate that interactional expertise can come in different strengths or degrees (2015). They insist, however, that even a minimal level of IE requires tacit knowledge acquired through prolonged immersion (though, again, how much time it would actually involve is unspecified and may depend on the technical level of the discipline and the interactional expert's existing knowledge).

[4] I experienced this first-hand when learning empirical research methods from a social scientist (e.g., survey design, semi-structured interviews, and qualitative data analysis). After reading several textbooks and journal articles in the field, I believed I understood the methods. Yet, it wasn't until I *applied* the methods and *performed* the analyses – and got feedback from my colleague along the way – that I had a full grasp of what was involved. Some of the most essential learning happened when my colleague taught me *how* social scientists actually put the lessons from the methodology textbooks into practice.

[5] Philosophers have made similar claims as well. For example, Henk de Regt (2017) argues that scientific understanding requires tacit knowledge, which "can only be acquired in a social context, by participating in the shared practices of a social group, for example, a scientific community" (p. 27).

[6] Selinger and Mix (2004) also argue that some interactional experts will be able to contribute meaningfully to scientific domains. As an example, they point to Epstein's (1995) discussion of the AIDS activists who successfully changed standard practices for clinical trials.

written documents (Collins & Evans, 2007; de Regt, 2017; Polyani 1958). It is typically learned through observing the way others talk and behave and by interacting with them – i.e., through experience. In what follows, I discuss how tacit knowledge can improve interactional experts' understanding of scientific knowledge (section 3.1). I then argue that immersion confers additional advantages, which I call 'socio--epistemic' benefits in that they capture knowledge arising from social observations and interactions (section 3.2). These benefits not only strengthen interactional experts' understanding of a field, but they can also facilitate the *uptake* of one's ideas and enhance their ability to contribute.

3.1. Tacit knowledge

One of the main types of tacit knowledge essential for linguistic fluency is understanding how experts actually *use* particular concepts. According to Collins and Evans, "it is the contributory experts not the interactional experts who define and develop the content of the language that the interactional experts try to master" (2007, p. 39). While this view may be a bit too narrow – certainly, philosophers have contributed to the articulation and clarification of scientific concepts – it is often helpful to see how scientists use concepts in conversation with one another. In my early work, for example, I sought to analyze particular concepts that were ill-defined in the scientific literature. Some of the textbooks I read included multiple incompatible definitions of the very same concept, making it difficult to determine how the concept was actually functioning in practice. It wasn't until I heard scientists using the concepts in various contexts that I realized different versions of the same concept were at work and that slippage between them was a major cause of problematic inferences (a fact that went unnoticed amongst most of the scientists themselves).

A second example of tacit knowledge is what Collins and Evans call 'concealed knowledge'. This includes scientists' 'tricks of the trade' that guide their scientific practice, such as how to deal with finicky lab equipment or the best ways for recruiting human subjects. While this type of knowledge may not always be essential for acquiring interactional expertise, it is beneficial for those who wish to understand particular details of the scientific knowledge-generation process that are not typically encoded in texts.

3.2. Socio-epistemic benefits

Immersion in a relevant scientific community can also enhance interactional experts' understanding of what I call the socio-epistemic aspects of scientists' thinking and practice, which can enable one to go beyond the acquisition of linguistic fluency. In particular, such understanding can facilitate bi-directional knowledge flow between interactional experts and scientific communities, even cultivating interactional experts' abilities to contribute to, or critically challenge, scientific practice.

One constellation of socio-epistemic factors includes scientists' motivations and beliefs concerning their research questions, methods, and findings. For example: What problems do scientists think are important in their field? What do most scientists in a particular field believe regarding the effectiveness of a particular method or the justification of a key assumption? Which scientists tend to be the loudest or are most likely to get uptake within or outside their discipline? How do scientists interpret (or misinterpret) criticisms of their work? Which critics are being listened to and which are ignored? Answers to these questions can provide a better understanding of how scientists generate and validate knowledge claims. As I discuss in section 4, this type of information can be essential for developing rich epistemological accounts of science.

Immersion can thus help aspiring IEs create an 'epistemic map' of a scientific community. Epistemic maps can capture areas of general consensus as well as important epistemic or doxastic (belief-related) heterogeneity that might otherwise go unnoticed (e.g., if there is a vocal minority in a scientific field that is producing a distorted view of the community). Collins himself notes, "in learning to use words as the community around one uses words, one is learning things of practical importance. One is learning what and who is to be taken seriously, and such things are some of the crucial components of practical judgments" (2011, p. 282). This type of understanding can be beneficial both to IEs whose main aim is to understand the process of how scientific knowledge is generated (which is the case for many philosophers of science) as well as those who wish to challenge or change scientific thinking or practice (e.g., the AIDS activists discussed in Epstein's (1995) work).

Understanding the social structure of a scientific community can also enable IEs to identify potential allies (critically-minded scientists who are willing to engage with interested outsiders), which has several benefits. First, allies may be willing to take the time to give IEs "insider" information about a field, including which papers to read or what conferences are worth attending. Second, allies can help IEs understand the (often tacit) norms of a discipline – this is important if, for example, an IE wishes to publish in scientific journals.[7] Third, allies may be more willing to talk with IEs to enhance the latter's understanding of the science or give them feedback on their work (e.g., to ensure it is descriptively adequate). Finally, allies can help IEs gain credibility with the larger scientific community, vouching for IEs among their colleagues.

Immersion can also provide an opportunity to develop trust and credibility with experts in a field. As other philosophers have demonstrated, trust plays an important role in both knowledge generation and dissemination. Much of the philosophical literature has focused on trust among individuals in an expert community (Hardwig, 1991) or trust between expert and lay communities (Grasswick, 2010; Whyte & Crease, 2010). While the latter is applicable to interactional experts, it is also important to consider the role of trust between contributory and interactional experts, where the IEs themselves may have expertise in other fields, such as philosophy, history, or sociology of science. For IEs, cultivating trust typically requires open-mindedness and a willingness to listen, demonstrating that one is committed to understanding others' perspectives. In my own experience, I found that learning the language was often enough to demonstrate such a commitment.

Building trust can facilitate knowledge flow in two directions: from the contributory experts to interactional experts, and from interactional experts back to contributory experts in the form of new ways of thinking or critical challenges to a field. In the former case, building trust with contributory experts may make them more willing to share their unwritten beliefs or views about a particular subject, enhancing the first type of socio-epistemic benefit of immersion. When it comes to influencing scientific thinking and practice, trust can improve one's credibility among contributory experts, which can facilitate *their* open-mindedness and willingness to listen – even to criticisms of their work.

Carla Fehr offers a useful example of how engaging scientists can enable philosophers to develop relationships and shared perspectives with scientists, which in turn may lead scientists to view those philosophers as credible interlocutors (Fehr, 2012). In particular, Fehr argues that feminist philosophers of science who wish to improve research in evolutionary psychology would be wise to engage with feminist scientists (who, in her example, can be identified through membership in the

[7] In one of the interviews I conducted as part of my empirical research, a philosopher of physics noted that they had been unsuccessful in publishing their work in physics journals despite knowing a lot about the science. They attributed this lack of success to the different writing and publishing norms in physics, which they did not fully understand. Such norms are often tacit and thus can be difficult to adopt without training or experience working in that field. Thus, it was not surprising when many of the philosophers of science I interviewed who had published in science journals emphasized their working relationships with scientists. For more on the importance of understanding procedural norms when collaborating, see Thagard (2006).

Feminist Evolutionary Psychology Society, or FEPS). As Fehr points out, FEPS members may be more attuned to the gender biases that underlie work in evolutionary psychology, and thus are more likely to be receptive to epistemic and ethical critiques of the field. By engaging with them, philosophers can increase the chance that their criticisms are given uptake by practicing scientists. In essence, Fehr's work highlights the benefits of cultivating allies in the field with whom one can build relationships and influence scientific practice.

3.3. What do these benefits enable an interactional expert to do?

The various tacit, socio-epistemic, and relational aspects of a scientific community discussed above are often intertwined and co-facilitating. To see what this process might look like, I describe my own experience engaging with a scientific community over several years. First, before engaging with any scientists, I read key texts and sat in on relevant courses to ensure I had a basic understanding of important concepts, methods, and findings in the field. (On Collins and Evans' account, this likely put me at the level of primary source knowledge. Notably, I already had an undergraduate degree relevant to the field I was engaging.) Next, I set up informal meetings with scientists to ask questions about the concepts I was targeting in my philosophical work. As a result of those connections, I was eventually invited to attend a weekly seminar (akin to a lab group meeting) with the scientists and graduate students working and studying in that field. For several months, I focused on listening – listening to how the other participants used the key concepts I was analyzing, listening for the issues that interested them, and listening to them share their views about research in their field. I then began to raise questions and share my own thoughts. Eventually, my input was regularly solicited, especially regarding the ethical and epistemic aspects of the science, which enabled me to bring philosophical criticisms to the table. When I later presented my philosophical work at a science conference, one of the scientists from the weekly seminar (who gave the presidential address at the conference) introduced me as a "philosopher who knows the science" and is "worth listening to." As a result, my talk was very well attended and scientists seemed to be more open to the criticisms I was making because their colleague – a highly respected member of the field – had vouched for me. In the years following this talk, I've been approached by several scientists in the field seeking input on their work (e.g., regarding the ability to draw causal inferences despite the limitations of their methodologies), and have even been asked to organize a session with philosophers of science at their association's annual meeting. Most recently, this led to the opportunity for me to collaborate with scientists where I articulated philosophical criticisms that helped to create and motivate a methodological advancement in the field (Burt, Plaisance, & Hambrick, 2019).

This example demonstrates how immersion or sustained interaction can afford interactional experts the ability not only to better understand the socio-epistemic landscape of a discipline, but also to improve the likelihood that their criticisms or potential contributions will be given uptake among expert communities. One way to think of immersion, then, is in terms of 'affordances', a term that represents what an environment provides or furnishes an individual (Hinton, 2014). Affordances have been cast in terms of perceived 'possibilities of action' (Hinton, 2014). In the case of interactional expertise, the environment of the expert community can afford an interactional expert the opportunity to identify potential pathways for having an impact on scientists' thinking and practice.

The issue of affordance raises the question, what does interactional expertise allow one to *do* (besides just speak the language of a discipline)? Most of Collins and Evans' work focuses on defining interactional expertise, discussing how it is acquired, and developing an account of how it can be identified.[8] But this leaves open the questions of *why* someone would want to become an interactional expert and *what* they can do with it (i.e., what we might call one's 'epistemic capacities').

Eric Kennedy addresses the motivational question in his (2019) paper, "Why they've immersed: A framework for understanding and attending to motivational differences among interactional experts." Kennedy posits four major motivations for acquiring interactional expertise, which he casts in terms of the potential roles IEs might take up: learner, challenger, collaborator, and facilitator. Learners "are motivated by a desire to learn, analyze, or understand a specialist domain," though they will often be in a good position to critique scientific work given their "commitment to listening and learning first" (2019, p. 223). Challengers seek to change scientific practice such that learning the science is merely a means to an end for them. Collaborators, on the other hand, often have goals that they share with scientists, and their main motivation for learning the science is to enable them to work *with* scientists on particular projects. Finally, facilitators are those who want to acquire IE so they can facilitate knowledge exchange between individuals or communities, such as the 'trusted mediators' discussed in Whyte and Crease (2010). Importantly, Kennedy notes that someone can have multiple motivations for becoming an IE and that such motivations can change over time.

Ribeiro and Lima (2016) take up the complementary question of *what* interactional experts can do, arguing that it is possible to trace particular (epistemic) abilities to different types of interactions or immersive experiences. Furthermore, they argue that the types of benefits I emphasize here – such as understanding the epistemic structure of a scientific community – may be *required* to conduct sociological analyses of a scientific discipline. In other words, the tacit knowledge and linguistic fluency acquired through interactional expertise alone might not be sufficient for some purposes. While Ribeiro and Lima highlight the need for these other types of benefits for sociological analyses, their argument can also be applied to philosophers who wish to influence scientific practice.

As I argue below, each of the roles Kennedy lays out are legitimate ones for philosophers of science (and the socio-epistemic benefits of immersion may be required for particular goals, as suggested by Ribeiro and Lima). Moreover, it would likely benefit philosophy of science to have diverse epistemic capacities represented amongst members of the discipline. This would require different types and levels of engagement, including non-engagement in some cases as I discuss in section 5.

4. Philosophers of science as interactional experts

One of the aims of this paper is to demonstrate the philosophical benefits that arise from having some philosophers of science acquire interactional expertise. In what follows, I illustrate how the linguistic abilities and tacit knowledge acquired through immersion can improve one's philosophical work (for at least some types of philosophical projects). I also argue that immersion can enhance philosophers' abilities to have an impact in scientific domains, which can benefit science, society, and philosophy. To support these claims, I draw on several examples of philosophical work (section 4.1), as well as the results of an empirical research project on the relationship between philosophy of science and scientific domains, which included semi-structured interviews with 35 philosophers of science (section 4.2). The methodological details of that study can be found in Plaisance et al. (2020).

[8] Collins and Evans, and several collaborators, have also done empirical work to test the strong interactional hypothesis (e.g. Collins, Evans, Ribeiro, & Hall, 2006).

4.1. The philosophical benefits of immersion

The first and most straightforward benefit of immersion is increased *descriptive adequacy* (and perhaps even descriptive comprehensiveness) of philosophical accounts of science. This benefit will most likely apply to philosophical work that analyzes epistemological aspects of scientific practice. By immersing oneself in a scientific community and/or interacting with scientists, philosophers have the opportunity to ensure that their accounts fit with current scientific practices and with the tacit knowledge and norms that tend not to be included in scientific publications.

Second, immersion can enable philosophers to develop novel philosophical accounts. Ken Waters' work on the gene concept is a good illustration of this type of benefit (and for those who agree with his account, of descriptive adequacy as well). As he discusses in his (1994) paper, "Genes Made Molecular," textbook definitions of the term 'gene' varied and were sometimes even incompatible with one another; as a result, many philosophers of science argued that there was no unified gene concept. However, once Waters immersed himself in a community of molecular biologists, he began to see how biologists used the term 'gene' in different ways and yet had no trouble understanding different instances of its use.[9] As Waters argues, biologists draw on the surrounding context of the term to infer what sense of 'gene' is being used (e.g., a nucleotide sequence that includes both introns and exons vs. a nucleotide sequence with the introns spliced out). Thus, although there were different uses of the term, they all had an underlying unity to them. Waters insists that this is not something he would have been able to discover solely through reading articles – rather, immersing himself in a community of practicing scientists and listening to them talk to one another was essential for developing this insight. Interestingly, Waters also notes that interviewing scientists – an approach that he tried – would not have been sufficient either, as many scientists have difficulty articulating their own tacit knowledge. By immersing himself, he was able to analyze the way scientists spoke to one another, which enabled him to understand their use of the gene concept.

Third, immersion can shed new light on traditional philosophical debates (Fehr & Plaisance, 2010). Heather Douglas illustrates this in a paper advocating for engaging with scientists and/or the users of science "on the ground," rather than just applying philosophical theories "off the shelf' to science or science policy (Douglas, 2010). As she demonstrates, engaging with scientific practitioners has enabled philosophers to identify flaws in theories of scientific explanation, prediction, and weight of evidence. Similarly, immersion and engagement can raise new philosophical questions, as Nancy Tuana illustrates in her discussion of coupled ethical-epistemic issues in science (Tuana, 2010).

Admittedly, much of the philosophical work attending to scientific practice can be done – and indeed has been done – without immersion in scientific communities. Exactly how much immersion or engagement is needed, if any, will depend on the importance of tacit knowledge for developing a philosophical account, and on an individual philosopher's goals. If one wishes to be a learner (in Kennedy's sense), prolonged immersion may or may not be required. Rather, short-term interactions may suffice; in some cases, philosophers can conduct descriptively adequate analyses of science without engaging scientists at all. (Waters' experience suggests that this won't always be the case, however.) Furthermore, engagement may be required – or would at least be beneficial – for philosophers who want their work to be taken up by scientists. The linguistic abilities that Collins and Evans emphasize are certainly useful, as linguistic fluency can lend credibility and allow for more productive conversation; however, the socio-epistemic benefits detailed above can be just as important – if not *more* important – when it comes to uptake, as I discuss below.

[9] Ken Waters, personal communication, July 2019.

4.2. How philosophers of science can influence scientific thinking and practice

Thus far, my analysis has suggested a mechanism for increasing the uptake of philosophical work in scientific domains. Specifically, immersion can enable a philosopher of science to understand the problems that motivate scientists, identify potential allies, and develop trust and credibility among those in the relevant scientific community, all of which can increase the chance of uptake. It would be helpful, though, if we also had empirical evidence that could support the success of this approach. Fortunately, I was able to gather such evidence through an empirical project on the relationship between philosophy of science and scientific domains. As part of that research, I conducted 35 semi-structured interviews with philosophers of science who work in a variety of areas, such as philosophy of biology, philosophy of physics, and science and values (see Plaisance et al., 2020 for details about the study's aims and methodology; notably, this study was done in collaboration with a social scientist who has methodological expertise in interviewing techniques and qualitative data analysis). I discuss the results of this study below to demonstrate support for the mechanism of influence proposed here.

One of the aims of the interviews was to determine which pathways are more likely to lead to broader uptake of philosophical work. Our analysis indicated that *face-to-face engagement* was one of the most effective – if not *the* most effective – means of getting uptake in other disciplines (Plaisance et al., 2020). Unfortunately, we were unable to determine whether prolonged engagement was necessary for this effect or whether short-term interactions with scientists would suffice (further study is needed to examine this distinction). Still, two key takeaways from the study support my argument that immersion can confer socio-epistemic benefits and in turn facilitate the uptake of one's work. First, several participants had experienced prolonged engagement with a scientist or scientific community that they believed led to results which would not have been the same without such engagement. Second, even when engagement was short-term, participants often cited the importance of trying to understand scientists' perspectives, of building trust or establishing credibility with scientists, and of identifying scientists who would be more open to philosophical criticisms (i.e., allies). This suggests that the socio-epistemic benefits I have identified can be acquired without full immersion (and thus without having to obtain full-blown interactional expertise), though immersion may make it easier to acquire such benefits.

There are a couple of examples from the interviews that nicely demonstrate the benefits of acquiring interactional expertise, both in terms of linguistic fluency and in terms of the socio-epistemic benefits of immersion. (Names have been redacted in accordance with consent procedures.) Participant A is a philosopher of science who has worked with scientists to help them identify the role values play in their research. In their interview, they discussed the importance of identifying scientists who are open-minded and willing to work with philosophers, taking the time to learn the science, and of being willing to learn the language. As they put it, "What works well is that we are two people who are open to learning from one another, and who both believe that by working together our work will be better than if we do it alone." (Interestingly, this participant was one of the few who characterized this as a two-way street where the scientists they worked with learned some philosophy as well.) Participant B is a philosopher of science who spent a year "hanging out" in a science lab during graduate school, regularly interacts with scientists at conferences, and has co-authored with scientists in a variety of journals. This participant highlighted the benefits of interacting with scientists early in their career: "I had this entrée into parts of the [scientific] community. I had done work with these people, which means you've kind of got a stamp of approval that you can get in the door of a workshop, or you can write a paper and get people to give you feedback on it." Participant B has contributed new theories to the scientific field in which they arguably hold interactional expertise.

Interestingly, participant B notes that most of their impact has occurred through direct conversation with scientists, rather than through publications (though subsequent citations of their published papers often function as another 'stamp of approval').

In addition to identifying face-to-face engagement as the most promising pathway to impact, our study also demonstrated the wide variety of impacts philosophers of science can have in scientific domains. In particular, six main themes emerged with respect to types of impacts.[10] These include: analyzing scientific concepts, identifying problems with scientific methods or inferences (and offering alternatives for scientists to consider), highlighting the role of values in scientific research, contributing to the development of new scientific knowledge, enhancing science policy, and improving science education. The first four of these demonstrate the potential to influence the practices and products of science. For each of those four themes, we were able to identify one or more participants who had immersed themselves in a scientific community and who cited the immersive experience as essential for the uptake of their work. Participant A's work, for example, illustrates the third theme (highlighting the role of values in science), and Participant B's work illustrates the fourth (contributing a novel theoretical framework to a scientific discipline).

These examples demonstrate the potential for philosophers of science to leverage the benefits of immersion in order to influence scientists' thinking and practice, which can lead to improvements in scientific practice or contributions to the advancement of science (oftentimes, enhancing their philosophical work in the process). In other words, these are examples of *contributing interactional experts,* which Collins and Evans initially thought would be rare.[11] What's more, some philosophers of science (and perhaps other interactional experts) may be in a *better* position to make a particular type of criticism or contribution with respect to scientific work. As Hubert Dreyfus points out, contributory experts often act intuitively, either without following explicit rules or following them unconsciously, using tacit norms to drive their work (Dreyfus 1958; cited in Collins & Evans, 2007). Philosophers of science, on the other hand, have a different relationship to science: in most cases, their education does not include enculturation into a particular scientific discipline (and thus, they do not unconsciously take up the tacit norms of science).[12] Furthermore, philosophers are trained in analyzing concepts, examining inferences, and identifying assumptions underlying scientists' work. (Collins and Evans call this 'referred expertise' when expertise from one domain is applied to another.) Thus, it may be easier for many philosophers of science to identify or articulate a problematic assumption or methodological limitation that, when addressed, can improve science.[13]

Engagement with scientists provides significant benefits for philosophers of science that might be difficult to obtain otherwise. To be clear, I am not suggesting that all – or even most – philosophers of science ought to engage science in this way (in fact, I discuss some of the downsides of immersion in section 5). However, having *some* philosophers of science become interactional experts enhances the diverse set of epistemic capacities of philosophy of science as a whole, allowing philosophers of science to put their knowledge into practice in more ways. Furthermore, those who become interactional experts and develop relationships with scientific communities can serve as epistemic bridge-builders between philosophy and other disciplines, translating philosophical criticisms into potential actions for scientists or even science policymakers.

4.3. Why (some) philosophers of science should aim for broader impacts

At this point, it is worth considering whether philosophers of science have an *obligation* to influence scientific thinking and practice. To answer this question, it is helpful to distinguish between the goals of a discipline versus the goals of particular individuals, and to consider obligations at the community level. Fehr and Plaisance (2010) make this move, arguing that philosophy of science, *as a community*, has an obligation to ensure that it has positive impacts on both science and society. This does not mean that every philosopher of science should aim to meet this obligation. However, Fehr and Plaisance argue that other philosophers of science should support high-quality philosophical work that is disseminated outside philosophical venues (e.g., to scientists, policymakers, and lay publics).

Another way to think about this obligation is by reflexively applying Heidi Grasswick's (2010) argument about the need for scientists to cultivate trust with stakeholders and broader publics. As Grasswick argues, one of the constitutive goals of science is the application and uptake of scientific knowledge amongst potential users of scientific knowledge and technology. If those users fail to understand – or, worse yet, if they distrust – scientific findings, scientific communities have an obligation to address the issue, in part because they are in the best position to understand the knowledge they generated (and how they generated it, which can be important to convey in order to demonstrate the trustworthiness of scientific research). We could say the same of philosophy of science, noting that while scientists may have an obligation to seek out critical analyses of their work, philosophers of science should still make that work *accessible* to them. Fehr (2012) advances this latter point, advocating for engaged philosophy of science that actively disseminates philosophical analyses and critiques to relevant communities.

Once again, we can turn to empirical data to determine the extent to which these positions are held by other philosophers of science. As discussed in Plaisance et al. (2019), I worked with social scientists to conduct a survey of 299 philosophers of science about their attitudes towards and experiences with broadly engaged work. One of the questions we asked philosophers of science was about the obligations they thought philosophy of science has as a community. Over 60% of the respondents agreed or strongly agreed that philosophy of science ought to ensure philosophical work has an impact on science (only 18% disagreed or strongly disagreed – the rest were neutral). Valerie Tiberius reported similar results in her survey of philosophers more generally, which indicated "moderate support for the idea that philosophy should engage with the 'real world'" (2017, p. 72). Again, while this does not mean that all philosophers ought to engage other communities, it does suggest that those who support engaged approaches and the need for broader impacts are not in the minority.

5. The costs of acquiring interactional expertise

Despite its benefits, acquiring interactional expertise can be incredibly time-consuming. While Collins and Evans don't say exactly how much time it can take, it seems to be on the order of months or even years (2007). In my own experience, it took about two to three years of sustained interaction with scientists to get to the point where I could converse fluently. This was time well spent, in my case, as immersing myself in the relevant community is what allowed me to determine how scientists were using the concepts that were the target of my analysis (much like Waters' work on the gene concept). Furthermore, my motivations have since shifted from what Kennedy calls a 'learner' to a 'collaborator' or 'challenger' – depending on the context – and each of these goals requires building rapport with scientists to be successful. For those who do not share these goals, it may be unwise to put so much time and effort into acquiring interactional expertise (especially for those

[10] These are discussed in more detail in Plaisance et al., 2020.

[11] They have since changed their position on this. See Collins and Evans (2015).

[12] While many philosophers of science have some education and/or training in science, most do not have advanced graduate degrees, which is likely when most of the enculturation occurs.

[13] Dan Dennett (2009) makes a similar argument concerning philosophers' potential contributions to cognitive science.

who do not have the protection granted by tenure). Moreover, whether one will be *able* to immerse also depends on the availability of a relevant and receptive scientific community. In my case, there was a community of relevant scientists at the institution where I received my PhD; luckily, those scientists had very positive views towards philosophy and its potential to strengthen scientific work. Individual philosophers of science should reflect on their goals and determine the best and most efficient ways of achieving them given their current position. Notably, there are some cases where immersion will turn out to be *less* time-consuming than identifying and reading through the relevant scientific literature on one's own.[14] Thus, even when immersion or engagement isn't strictly necessary, it may still be a more efficient way of learning the science, depending on one's philosophical questions and goals.

A second, and more philosophically significant, downside of immersion is that one may lose "critical distance" when they are immersed in a scientific community (this is more likely to happen in cases of sustained immersion than for short-term interactions). In fact, in one of the interviews I conducted, a philosopher of science noted that the more they developed collaborative relationships with particular scientists, the more they felt apprehensive about voicing criticisms of those scientists' work. Thus, maintaining critical distance can have its benefits. An example of this can be seen in John Dupré's (2001) analysis of the epistemic and ethical problems with evolutionary psychology. Notably, Dupré did not engage with evolutionary psychologists when doing his work – and from what I gather, this lack of engagement was intentional. In this case, it is reasonable to assume that the targets of Dupré's criticisms (who include evolutionary psychologists like David Buss) would not be receptive to Dupré's criticisms, even if he were to acquire interactional expertise in evolutionary psychology. (I'm basing this assumption on evolutionary psychologists' responses to other philosophical work, like that of David Buller, which seem to indicate a lack of serious consideration and uptake of philosophical criticisms.) While I do not know Dupré's ultimate goals, one interpretation of his approach might be that by *not* engaging, he was able to maintain critical distance, aiming instead to inform and persuade others – such as philosophers, publics, and perhaps even funding agencies – of the problems he identified.

One way to address the potential downsides of losing critical distance is by having a spectrum of engagement amongst philosophers of science (Fehr (2012) advocates for this pluralistic view). At the individual level, philosophers of science will need to consider their own goals and whether or not immersion is needed. In some cases, even brief interactions are sufficient to learn what is needed about the science and can be more efficient than reading scientists' published work by itself; in others, interaction is not needed and may not even be desirable. In general, though, it is a good idea to be intentional and/or reflective about one's approaches. In particular, one ought to consider what might be gained and what might be lost as a result of immersion or engagement (keeping in mind that not all consequences can be foreseen).

Finally, one might ask whether full-blown interactional expertise is really necessary for descriptive adequacy and/or to get uptake amongst scientific communities. The answer is: it depends. There are certainly examples of philosophers whose work is relevant to science but who do not interact much (if at all) with their target communities, and whose ideas still get uptake amongst scientists. Helen Longino's work is a good example of this. In her most recent book, *Studying Human Behavior*, Longino offers detailed conceptual and methodological analyses of five scientific fields: behavior genetics, socialization research, developmental psychobiology, neuroscience, and the more recent G x E (genotype x environment) approaches (Longino, 2013). Longino did not immerse herself in any of these communities to do her work; rather, she primarily relied on reading empirical papers in each field.[15] However, she validated her understanding of the science by talking to relevant scientists and asking them to read portions of her work. Furthermore, Longino had an immersive experience early in her career through a one-year fellowship she received to work with biologists. As Longino recounts, that opportunity not only enabled her to learn a lot of biology fairly quickly, but it also gave her an appreciation of how scientists think and even led to co-authorship with a scientist (thus giving her exposure to the writing and publishing norms of that discipline). The insights Longino gained about how science works (based on tacit knowledge acquired through her immersive experience) was likely helpful in her later research, perhaps even making it less important for her to engage beyond short-term interactions. Similarly, while some of the philosophers of science I interviewed believed that immersion was necessary for having the impact they sought, others seem to have acquired the socio-epistemic benefits of immersion (e.g., access to tacit knowledge and building rapport) through shorter-term interactions with scientists, such as one-off conversations at science conferences.

Whether full-blown interactional expertise is necessary – or, at least, more effective – for achieving particular epistemic goals is likely an empirical question, the answer to which will vary by context. What the interviews with philosophers of science (as well as the examples discussed above) indicate is that the tacit knowledge and socio-epistemic benefits that come from acquiring interactional expertise can enhance philosophical accounts and improve one's ability to effect change in scientific domains. In future work, it would be useful to tease apart the roles of linguistic ability vs. the socio-epistemic or relational benefits of immersion. This might be done by comparing interactional experts who have focused less on developing relationships with members of their target community with those who do not have linguistic fluency but who have cultivated trust with scientists. In the latter cases, it may be that one-on-one conversations allow enough of an immersive experience to acquire important tacit knowledge even if it doesn't result in fluency (it is not clear whether Collins and Evans would rule this out, or whether they would argue that observing scientists talking to *one another* is essential for interactional expertise).

6. Conclusion: building diverse epistemic capacities in philosophy of science

As I've argued in this paper, acquiring interactional expertise not only enables one to speak the language of a discipline, but it also offers socio-epistemic benefits such as having access to scientists' unwritten views and the opportunity to build trust. These benefits can enhance certain types of philosophical work and facilitate the broader uptake of philosophical criticisms and insights. In fact, for some purposes, the socio-epistemic or relational benefits may be *more* important than linguistic fluency. These benefits, however, do not come without a cost: immersion can be time-consuming, effortful, and may reduce critical distance. One way to address these concerns is to think about philosophical engagement with other communities at the disciplinary level and advocate for a spectrum of engagement between philosophers and scientific communities. This could include no engagement or engagement only with texts (what Collins and Evans call 'primary source knowledge'); short-term interactions (e.g., to verify one's understanding of the science); immersive experiences that confer interactional expertise; and, finally, long-term collaborations with scientists.[16]

[14] I am grateful to an anonymous referee for making this point. As they put it, "it is just *way easier* to learn about scientific debates by directly interacting with scientists. It is also a wonderful way of getting inspiration for philosophical papers."

[15] Longino, personal communication, February 2019.

[16] Elsewhere, Kevin Elliott and I develop a more comprehensive account of different forms of engagement (Plaisance & Elliott, 2020).

Cultivating a range of approaches can enable philosophy of science, as a community, to develop diverse epistemic capacities (some engaged, some not; some critical, others collaborative).[17] This means that philosophers of science would not only *know* different things, and be able to *generate* different types of knowledge, but they could *do* different things with their epistemic capabilities. For example, some philosophers of science might focus on developing complex accounts of causation, while others consider how causal inferences are and should be made in particular scientific disciplines; yet others can draw on this philosophical work to critique the way those inferences are made by practicing scientists, or even work *with* scientists to better align scientists' inferences with their data. Other philosophical topics, such as science and values, would also lend themselves to this diverse set of approaches, resulting in both well-developed philosophical accounts *and* improvement in scientists' abilities to identify and critically evaluate the values embedded in their decision-making (or even lay publics' abilities to recognize problems with the 'value-free ideal' of science).

If we care about getting our knowledge into the hands of those who can use it, having some philosophers acquire interactional expertise in scientific fields can help.[18] This does not mean that philosophers should be seen as underlaborers to science; indeed, part of our work includes holding scientists accountable for addressing epistemic and ethical problems in their research (and, some would argue, improving non-scientists' abilities to think critically about science). These goals do not need to be held by everyone in the discipline, though recent empirical work suggests that many philosophers of science think the discipline ought to ensure it has an impact on science (and on society more generally). Furthermore, the interviews discussed above give us good reason to believe that face-to-face engagement (which sometimes includes full immersion) is an effective pathway to the broader uptake of philosophical work.

Even for philosophers who are not aiming to influence communities outside philosophy, the tacit knowledge acquired through engagement and immersion can improve philosophical work by way of increased descriptive adequacy and the generation of novel philosophical ideas and insights. Acquiring these benefits may be possible via short-term interactions, though some cases may necessitate the acquisition of full-blown interactional expertise. Thus, philosophers ought to consider their goals when planning their approaches.

Finally, while this paper is primarily intended to illustrate the benefits of acquiring interactional expertise for philosophers of science, the analysis provided here can also advance work on interactional expertise and the broader SEE framework in several ways. These include: articulating additional benefits of acquiring interactional expertise, offering a new case study (with philosophers of science as interactional experts in a scientific field), and demonstrating some of the capabilities of contributing interactional experts. While the concept of interactional expertise is not without its flaws, it certainly provides a useful framework for thinking about expertise across disciplines and the knowledge that can be acquired through human interaction.

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[17] I recently discovered work by Ian Werkheiser (2016) that uses the notion of 'community epistemic capacity'. While Werkheiser uses the term in relation to lay publics' epistemic capacities, I think it can be applied just as well to the capacities of philosophers.

[18] Note that much of what I said here can also apply to others outside philosophy, such as historians or rhetoricians of science.

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