CI

Introduction

CI.S1

Science and Scientific Testimony

CI.P1 The slogan of the Royal Society is *Nullius in verba*. While the exact translation and point of the slogan are debated, the core idea is, according to the Royal Society itself, that scientists should "take nobody's word for it" (Royal Society 2020). The key point is that science should be based on "facts determined by experiment" rather than on mere trust in authority.

CI.P2 This *Nullius in verba* sentiment is reflected in the philosophical foundations for an Enlightenment view of science. For example, Descartes's Rules for the Direction of the Mind explicitly forbids inquiring minds from relying on "what other people have thought" (Descartes 1628/1985: 13). Locke states, "In the Sciences, every one has so much as he really knows and comprehends: What he believes only and takes upon trust, are but shreads; which however well in the whole piece, make no considerable addition to his stock, who gathers them" (Locke 1690/1975: I.iv, 23). Kant, in turn, characterizes the Enlightenment itself in terms of the ability to understand things oneself without relying on others: "Enlightenment is man's emergence from his self-incurred immaturity. Immaturity is the inability to use one's own understanding without the guidance of another" (Kant 1784/1991: 54).

CI.P3 This book is not a historical treatise. If it were, it would reveal a more complex picture of scientific testimony in the philosophical foundations of the Enlightenment than these quotes might suggest. Likewise, critical historical studies suggest that the individualistic, anti-testimonial ethos of early scientists did not accurately reflect their scientific practice (Shapin 1994). Nevertheless, it is important to address the simplified picture that opposes testimony in science. Often, simplified pictures are more forceful than complex ones in influencing our *folk theory of science*.

CI.P4 For example, it is natural to think of science as an enterprise that produces "first-hand knowledge" from careful analysis of meticulous observation rather than mere "second-hand knowledge" from the testimony of someone else. According to this line of thought, the rest of us may defer to scientists' testimony precisely because the scientists themselves are autonomous in the sense that they base their views on observation rather than deferring to someone else's say-so (Dellsén 2020). Thus, a natural folk theory of science may well encompass an inarticulate yet influential *science-before-testimony* picture. According to this

Scientific Testimony: Its roles in science and society. Mikkel Gerken, Oxford University Press. © Mikkel Gerken 2022.
DOI: 10.1093/oso/9780198857273.003.0001

picture, scientific testimony's place in the scientific practice is after its conclusions have been established.

CI.P5 I venture to guess that many philosophers of science would now reject such a *science-before-testimony* picture and agree with Lipton's dictum: "Science is no refuge from the ubiquity of testimony" (Lipton 1998: 1). Philosophers of science have highlighted the importance of scientific collaboration and division of cognitive labor in philosophy of science. Yet, despite notable exceptions, philosophy of science features comparatively little work on the roles of scientific testimony. This is startling if scientific testimony is an important part of science rather than an add-on. In contrast, social epistemologists spend their days and nights theorizing about testimony, but they often do so without thematizing *scientific* testimony. Consequently, a central ambition of this book is to situate scientific testimony as a primary topic of investigation by drawing on both philosophy of science and social epistemology. I will try to not merely reject the *science-before-testimony* picture by articulating negative arguments against it. I will also begin to articulate a principled *testimony-within-science* alternative according to which scientific testimony is not merely a *product* of science but a *vital part* of it. This picture is painted by mixing philosophy of science and social epistemology. Developing a positive alternative picture that highlights the significance of scientific testimony is important because it helps us understand the nature of science. But it is also important because it puts us in a better position to ameliorate the role of science in society.

CI.P6 One main theme of the book will be the significance of what I call *intra-scientific testimony*, which is scientific testimony from a scientist that has collaborating scientists as its primary audience and which aims to further future scientific research. I will argue that intra-scientific testimony and the norms governing it are as vital to collaborative science as scientific norms governing observation, data analysis, theorizing, etc. While observations may be the building blocks of the scientific edifice, scientific testimony is required to unify them. In slogan: *Scientific testimony is the mortar of the scientific edifice*.

CI.P7 While the slogan provides a metaphorical contrast to the *Nullius in verba* slogan, I will make the metaphor more tangible by developing concrete norms of intra-scientific testimony. For example, I will propose an epistemic norm for providing intra-scientific testimony as well as a norm for its uptake in the context of scientific collaboration.

CI.P8 One reason to develop a positive alternative to the *science-before-testimony* picture is that it may continue to hold some sway in folk conceptions of science insofar as many laypersons may share the misconception that scientific progress owes to an autonomous individual genius. Just think about the image conveyed by the TED talk—the immensely popular platform for science communication—which is built around a solitary presenter musing in the spotlight. Likewise, history of science and science education often focuses on individual geniuses

such as Galileo, Newton, Darwin, and Einstein (Allchin 2003). But science is not well represented by focusing on individual efforts of great white males who, after a *Eureka!* moment, produce an entirely novel theory and prove it by a crucial experiment. A focus on such a narrative may give rise to what I call a *great white man fetish*, which is both misguided and likely to sustain structural injustices. In particular, I will argue that it may sustain *testimonial* injustice, which is an important species of epistemic injustice (Fricker 2007).

CI.P9 Folk misconceptions of science that are influenced by the *science-before-testimony* picture are relevant for another main theme of the book: *public scientific testimony*, which is scientific testimony that is primarily directed at the general lay public or select members of it such as policy makers. To address public scientific testimony, philosophical resources will be integrated with empirical work on laypersons' uptake of public scientific testimony in the novel interdisciplinary field called *the science of science communication* (Jamieson et al. 2017). In doing so, I focus on general norms of public scientific testimony that apply to both scientific expert testifiers and to science reporters. But I also articulate more specific guidelines that may inform their public scientific testimony. I develop such norms and guidelines on the basis of philosophical reflection on the nature of scientific testimony and its proper role in societies that pursue ideals of deliberative democracy. But although I pursue a principled account, I do not presuppose that the nature and role of scientific testimony are eternal truths that may be uncovered by a priori reflection alone. Rather, I also draw heavily on empirical research on the social context of public scientific testimony and of laypersons' psychological obstacles to a reasonable uptake of it. This engagement with the relevant empirical work is *critical* insofar as I criticize some proposals and articulate some important conceptual distinctions. But it is also *constructive* in that I draw on the empirical research to formulate working hypotheses on clearly empirical questions regarding folk misconceptions of science, cognitive biases, and strategies for overcoming these obstacles.

CI.P10 Given that I seek to address the significance of scientific testimony both within scientific practice and in the wider society by drawing on a broad range of philosophical and empirical resources, a couple of brief methodological preliminaries are in order.

CI.S2 Methodological Considerations

CI.P11 There are three methodological aspects of the book that readers should prepare themselves for: Reliance on approximate characterizations of paradigm cases, reliance on substantive background assumptions, and efforts to integrate disparate discussions. Let me say a bit about each.

CI.S3

Definitions vs Characterization of Paradigm Cases

CI.P12 The book concerns complex phenomena such as expertise, collaboration, groups, collective belief, public deliberation, and so forth. Since each of these phenomena is a self-standing research topic which involves debates over definitions, I must frequently work with approximate characterizations. This is no less true of the two core components of scientific testimony—namely, *science* and *testimony*.

CI.P13 The attempt to characterize science well enough to distinguish it from pseudo-science is a long-standing ambition of philosophy of science (Lakatos 1978; Hansson 2017). Likewise, contemporary epistemology and philosophy of language feature intense debates about the characterization of testimony. I have sought to reflect these debates without getting stuck in the pursuit of reductive analyses. In fact, I suspect that many of the phenomena are too basic to admit of reductive analyses. Rather, I will try to uncover, in a non-reductive manner, some principled, and sometimes constitutive, relations between the relevant phenomena (see Gerken 2017a for elaboration of such an *equilibristic* methodology). So, rather than hunting for necessary or jointly sufficient conditions, I will often provide a characterization in terms of some hallmark properties of paradigm cases and then restrict the discussion to such cases. Of course, some cases are hard to capture in this manner. For example, testimony given at a research conference that is open to the public lies in the gray zone between intra-scientific testimony and public scientific testimony. But although some cases are hard to categorize, many cases are clear enough. For example, the case of an epidemiologist who gives an interview on the radio may still be discussed as a paradigm case of public scientific testimony. So, I follow Kripke's *hard cases make bad law* methodology of beginning with the paradigm cases (Kripke 1979/2011: 160). When things go well, the account of paradigm cases may eventually be extended to harder peripheral or derivative cases. But this is not always an ambition of the present exploration. In sum, while the book contains a good deal of conceptual clarification, I have sought to strike a balance between working with clear characterizations and adopting approximations that will do for the purpose at hand.

CI.S4

Background Assumptions

CI.P14 Space and focus also dictate that I assume some substantive theoretical views without much argument. For example, I adopt a broadly realist background stance according to which approximating truth is an actual and reasonable aim of scientific theories (Psillos 1999; Godfrey-Smith 2003; Chakravartty 2011). While this remains a controversial assumption in the philosophy of science, it will be a working hypothesis that I will adopt with very little defense. Consequently, the parts of the investigation that rest on this stance may not speak to some scientific

anti-realists. On the other hand, one way to motivate a philosophical framework is to adopt it and consider whether a particular issue may be fruitfully investigated within it. This is my approach with regard to scientific realism in the present investigation. In other cases, I allow myself to rely on arguments that I have given elsewhere. For example, I will rely on previous criticisms of the knowledge-first program (see Gerken 2011, 2012a, 2014a, 2015b, 2017a, 2018a). There are other debates which I regard as very important, but which I have had to sidestep due to space and focus. One example is the debates concerning the value-free ideal of science—roughly, the idea that at least some central parts of the scientific enterprise should aim to be as neutral as possible with regard to non-cognitive values (Douglas 2009, 2015; Brown 2020). The value-free ideal has been the subject of intense debate, which bears on scientific testimony. In this case, I do not speak to the grand debate about the value-free ideal in scientific research (although I do have views on it). Rather, I rely on the much less controversial assumption that the practical ramifications of public scientific testimony bear on the conditions under which it is appropriate to assert it.

CI.S5

Integrative Efforts

CI.P15 Perhaps the most striking methodological aspect of the book is its close integration of related fields that sometimes fail to draw on each other. One such integration is between philosophy of science and (social) epistemology. The book is written from the conviction that an understanding of the significance of scientific testimony must be based on foundational theorizing in the epistemology of testimony. On the other hand, I have repeatedly found that reflecting on issues and cases in the philosophy of science informs fundamental issues about the nature of testimony. Scientific testimony is an area in which philosophy of science and (social) epistemology may be mutually illuminating. I hope that integrating these two adjacent subdisciplines of philosophy, which are often conducted in relative isolation from each other, will shed light on scientific testimony. More generally, I hope that the discussion will exemplify how philosophy of science and social epistemology may benefit from further integration.

CI.P16 Another important integration is between philosophy and the empirical *science of science communication*. For a philosopher, this interdisciplinary field is obviously valuable in providing empirical warrant for empirical assumptions. But I have also found it to be a treasure trove of novel ideas and perspectives on public scientific testimony. That said, the book is by no means an attempt to naturalize philosophy. On the contrary, I aim to provide both critical and constructive philosophical contributions to the debates. Often, they consist in foundational concepts, arguments, or distinctions between, for example, types of scientific testimony. Furthermore, empirically informed philosophical reflection

may provide substantive theses about the nature of scientific testimony, the norms that apply to it, and its role in scientific collaboration as well as in the wider society. Thus, I hope that the investigation will indicate that philosophy has a lot to contribute to the understanding of the significance of scientific testimony in science and society.

CI.S6

An Overview

CI.P17 The book consists of seven chapters and a brief coda. It is organized in four parts. The first three parts each consist of two chapters, and the final part consists of a concluding chapter and the coda.

CI.P18 **Part I: Philosophical Foundations of Scientific Testimony**. The first part of the book approaches its subject matter by some principled characterizations and by taxonomizing varieties of scientific testimony. Moreover, I articulate and motivate substantive theses about scientific testimony, epistemic expertise, scientific collaboration, etc. So, Part I contributes to the conceptual foundations for the investigation of scientific testimony.

CI.P19 In **Chapter 1**, I start the investigation with some conceptual clarifications and a provisional taxonomy of types of scientific testimony. Notably, this includes the distinction between *intra-scientific testimony*, which takes places between collaborating scientists, and *public scientific testimony*, which is directed at laypersons and comes in two varieties. *Scientific expert testimony* is characterized by the testifier being a scientific expert. *Science reporting*, in contrast, is public scientific testimony by testifiers, such as journalists, who often lack scientific expertise. Given this initial clarification of scientific testimony, I consider its relationship to prominent themes in philosophy of science. These include scientific expertise, scientific collaboration, and the division of cognitive labor. In discussing these themes, I articulate conceptual and empirical arguments that scientific collaboration contributes immensely to the epistemic force of science and that intra-scientific testimony is a vital part of such collaboration.

CI.P20 **Chapter 2** opens with a discussion of the nature of testimony as a speech act and an epistemic source. This discussion draws on foundational epistemological work involving, for example, the internalist/externalist debate and the reductionist/anti-reductionist debate. Relatedly, I consider the senses in which testimony may and may not be said to transfer epistemic warrant from testifier to recipient. Specifically, I argue for a negative principle, *Non-Inheritance of Scientific Justification*, according to which the kind or degree of scientific justification that the testifier possesses is typically *not* transmitted to the recipient—even when the testimonial exchange is epistemically successful. I will often view scientific testimony through the lens of norms. Consequently, Chapter 2 also includes a brief

discussion of *norms*, which I consider as objective benchmarks of assessment, and *guidelines*, which are more concrete directives that scientific testifiers may follow.

CI.P21 **Part II: Scientific Testimony within Science**. The two chapters that make up Part II address the nature of scientific testimony and the roles it plays *within* the scientific practice. On the basis of a characterization of scientific testimony, I focus on intra-scientific testimony's role in truth-conducive scientific collaboration.

CI.P22 **Chapter 3** provides a characterization of scientific testimony that differentiates it from other types of testimony. Specifically, I articulate and defend a characterization of scientific testimony as testimony that is properly based on scientific justification. Further specification of this characterization is provided by way of a discussion of some of the central properties of scientific justification. These include its being gradable, its being discursive, and the senses in which it is and is not epistemically superior to non-scientific justification. Likewise, I discuss what being properly based on scientific justification amounts to. Apart from helping to clarify what scientific testimony is, these arguments help to specify why intra-scientific testimony contributes to the epistemic force of collaborative science. Likewise, they help to specify why public scientific testimony may serve as a central epistemic authority in society.

CI.P23 In **Chapter 4**, I continue the overarching argument that intra-scientific testimony is a vital part of the scientific practice by articulating some norms for it. The first one is a *Norm of Intra-Scientific Testimony* (NIST), according to which a scientist who provides intra-scientific testimony within a scientific collaboration must base it on a contextually determined degree of scientific justification. I then turn from the producer side to the consumer side and develop a *Norm of Intra-Scientific Uptake* (NISU). According to NISU, a collaborating scientist receiving intra-scientific testimony should, as a default, believe or accept it insofar as he has strong and undefeated warrant for believing that the testimony is properly based on scientific justification. In developing this duo of norms of the production and consumption of intra-scientific testimony, I argue that they partly but centrally contribute to explaining the truth-conduciveness of scientific collaboration. This reflects the book's general attempt to replace a *science-before-testimony* picture with a *testimony-within-science* alternative according to which intra-scientific testimony is not an add-on to scientific practice but a vital part of it.

CI.P24 **Part III: *Scientific Testimony in Society***. In Part III, I turn to *public scientific testimony* and its roles in society. In particular, I will propose a number of norms and guidelines for *scientific expert testimony* and *science reporting*, respectively. My approach is informed by empirical research on the psychology of laypersons' uptake of public scientific testimony.

Chapter 5 concerns scientific expert testimony. It begins by surveying empirical research on psychological challenges for the public's uptake of public scientific testimony. On the basis of this work, I articulate a novel norm for scientific expert testifiers: *Justification Expert Testimony* (JET). According to JET, scientific expert

testifiers should, whenever feasible, include appropriate aspects of the nature and strength of scientific justification, or lack thereof, in their testimony for the scientific hypothesis in question. I furthermore argue that JET motivates a more specific guideline concerning *scientific expert trespassing testimony* which occurs when a scientific expert testifies on matters in a domain of epistemic expertise other than her own. According to this *Expert Trespassing Guideline*, a scientific expert who provides expert trespassing testimony should, in some contexts, qualify her testimony to indicate that it does not amount to expert testimony. So, Chapter 5 exemplifies the gradual movement from foundational research on general norms to applied research on more specific ameliorative guidelines.

Chapter 6 is devoted to *science reporting* and begins with a critical assessment of some prominent principles of science communication that appeal to scientific consensus, recipient values, etc. This serves as the background for my own proposal, *Justification Reporting*, which has it that science reporters should seek to include appropriate aspects of the nature and strength of scientific justification in science reporting. I consider the prospects and limitations of this norm in light of empirical research on laypersons' uptake of public scientific testimony. The chapter concludes with a more ameliorative perspective. Specifically, I consider the journalistic principle of *Balanced Reporting* according to which science reporters should seek to report opposing hypotheses in a manner that does not favor any one of them. By an application of *Justification Reporting*, I set forth an alternative, *Epistemically Balanced Reporting*, according to which science reporters should seek to report opposing hypotheses by indicating the nature and strength of their respective scientific justifications.

CI.P25 **Part IV: The Significance of Scientific Testimony**. Part IV consists of Chapter 7 and a short Coda. In Chapter 7, I draw the previous sub-conclusions together in arguments for general conclusions about the significance of intra-scientific testimony and public scientific testimony, respectively. The Coda briefly relates the central themes of the book to cognitive diversity and epistemic injustice.

CI.P26 **Chapter 7** begins with arguments for two theses concerning intra-scientific testimony. The first thesis, *Methodology*, is the claim that the distinctive norms governing intra-scientific testimony are vital to the scientific methods of collaborative science. The second thesis, *Parthood*, is the claim that intra-scientific testimony is a vital part of collaborative science. Jointly, these two theses help to replace the *science-before-testimony* picture with a *testimony-within-science* alternative. I then turn to arguments for two theses about public scientific testimony. The first thesis of this duo, *Enterprise*, has it that public scientific testimony is critical for the scientific enterprise in societies pursuing ideals of deliberative democracy. The second thesis, *Democracy*, is the claim that public scientific testimony is critical for societies pursuing ideals of deliberative democracy. In light of these two theses, I discuss the role of public scientific testimony in the

societal division of cognitive labor. In particular, I argue that it is an important societal task to secure a social environment in which laypeople may acquire epistemically entitled testimonial belief through *appreciative deference* to public scientific testimony. This results in a novel norm for laypersons' uptake of public scientific testimony.

CI.P27 **Coda.** The brief Coda indicates how scientific testimony relates to (cognitive) diversity and epistemic injustice. After characterizing these notions, I consider how cognitive diversity bears on intra-scientific testimony. I argue that it has good epistemic consequences in virtue of adding critical perspectives but also bad consequences in virtue of complicating intra-scientific communication. Relatedly, I note that cognitively diverse minorities' intra-scientific testimony is particularly liable to be received in epistemically unjust ways. Turning to public scientific testimony's relationship to cognitive diversity and epistemic injustice, I suggest that a social environment characterized by an appreciative deference to scientific testimony may help minimize some types of epistemic injustice for cognitively diverse or epistemically disadvantaged groups. On this basis, I suggest that social and institutional initiatives combating epistemic injustice for cognitively diverse groups should be central to the pursuit of the broader goal of aligning scientific expertise and democratic values.

CI.S7

Stylistic Notes

CI.P28 I label cases by italicized full capitalization. For example: As the case *WIND SPEED* exemplifies . . .

CI.P29 I label principles by upper and lower case italics. For example: According to the principle *Distinctive Norms*, science relies . . .

CI.P30 I label acronymized principles by full capitalization. For example: The principle NIST is one which . . .

CI.P31 I use single quotes to mention words and sentences. For example: The word 'testimony' which occurs in the sentence 'scientific testimony is important' is a controversial one.

CI.P32 I use double quotes for real or imagined quotations and occasionally to indicate metaphors or to introduce novel terminology.

CI.P33 I use italics for emphasis and occasionally to indicate quasi-technical phrases.

PART I

CP1

PHILOSOPHICAL FOUNDATIONS OF SCIENTIFIC TESTIMONY

CP1.P1 Part I of the book consists of two chapters concerning fundamental debates which are about, or relevant for, understanding scientific testimony. Thus, Part I contributes to laying the conceptual foundations for more specific arguments and theories about scientific testimony. It does so by surveying some of the relevant debates in philosophy of science and social epistemology. However, along the way, I will contribute to these debates by providing conceptual clarifications, making distinctions, and articulating substantive theses and principles.

CP1.P2 In Chapter 1, I distinguish among some central kinds of scientific testimony and consider it in relation to themes in philosophy of science, such as scientific expertise and scientific collaboration. On this basis, I begin to develop an account of the roles of scientific testimony in scientific collaboration that is characterized by a high degree of division of cognitive labor.

CP1.P3 In Chapter 2, I characterize the fundamental features of testimony in general, and as an epistemic source in particular. For example, I address central epistemic features of testimony by relating them to some foundational epistemological debates, such as the internalist/externalist debate and the reductionist/anti-reductionist debate. Finally, I consider how scientific testimony may be characterized via the epistemic norms governing it.

1

Testimony and the Scientific Enterprise

1.0 The Roles of Scientific Testimony

A study of scientific testimony involves considering the relationship between two phenomena: science and testimony. Consequently, I will begin with provisional characterizations of the relevant kinds of testimony and move on with some select points about the relevant aspects of the scientific process.

In Section 1.1, I will provide some core distinctions in a taxonomy of scientific testimony that I will examine. In Section 1.2, I distinguish among some varieties of scientific expertise at the individual level. In Section 1.3, I move to the social level by highlighting the collaborative aspects of the scientific process and method. Section 1.4 continues this theme by focusing on the division of cognitive labor that characterizes scientific work. In Section 1.5, I draw on these discussions to argue that the division of cognitive labor characteristic of science depends on distinctive *norms* of intra-scientific testimony. Thus, the chapter concludes by initiating arguments for a broad *testimony-within-science* picture.

1.1 Kinds of Scientific Testimony: Intra-Scientific and Public

Testimony is a varied phenomenon, and in order to provide some classification of the various types of *scientific* testimony, a bit of an overview is called for. So, I will briefly consider testimony in general before focusing on scientific testimony.

1.1.a Testimony in general: For the purposes of this book, I will think of testimony in a fairly broad manner as an assertive expression which is offered as a ground for belief or acceptance on its basis. Utterances or writings are central examples of testimony although they are not exhaustive. For example, representational depictions, maps, or icons may count as types of testimony—including types of scientific testimony. Likewise, nods, hand waves, and grimaces may qualify as testimony. However, I will focus on familiar written and spoken forms of propositional scientific testimony that purport to convey a worldly fact. I also construe testimony broadly as to include assertions that *p* that include a justification or explanation for *p*. Consider, for example, the assertion: "The meeting will be postponed. It makes no sense without the investor, and she is

Scientific Testimony: Its roles in science and society. Mikkel Gerken, Oxford University Press. © Mikkel Gerken 2022.
DOI: 10.1093/oso/9780198857273.003.0002

delayed." I take this to qualify as testimony that the meeting will be postponed although a rationale is given for this. Given the broad conception of testimony, it is all the more important to zoom in on scientific testimony and its species. There will be plenty of zooming in and out throughout the book. In this opening section, I will simply draw some basic distinctions and settle on some terminology.

C1.P5 Although the term 'testimony' has solemn and austere connotations, it may just consist in an everyday assertion. When Teo tells me that he had rye bread for lunch, he is testifying in this relaxed sense of the term. When I believe him, I form a *testimonial belief*. Likewise, when I read that FC Barcelona won El Clásico 5–0, I read a testimony and my resulting belief is a paradigmatic testimonial belief (I elaborate in Chapter 2.1.a–b). Scientific testimony may have the same relaxed character. My testimonial belief that nothing travels faster than light may be formed much like my testimonial belief that Barça won El Clásico 5–0. So, testimony need not occur in courtrooms or in formal pronouncements.

C1.P6 Terminologically speaking, we may follow Coady in distinguishing between *formal* testimony, such as in a courtroom, and *natural* testimony, such as Teo's one about rye bread.[1] While the distinction is helpful, many of the cases that will be discussed are situated in a gray zone between these categories. For example, an assertion in response to a question at a scientific conference has aspects of both natural and formal testimony. Likewise, a scientist's quotes in a semi-structured interview for a newspaper have aspects of both natural and formal testimony.

C1.P7 Turning to the recipient's side, the idea of a *minimal background case* is a useful one that I will rely on: In a minimal background case, the recipient has minimal information about the testifier and the testifier's epistemically relevant properties, such as his competence, reliability, and sincerity. Minimal background cases also involve minimal warrant for beliefs about the broader informational environment. Of course, the recipient will always have some background information (Audi 2006: 27–8). So, minimal background cases are limiting cases that contrast with cases with richer background information. A good example is that of an epistemologically naïve recipient, such as a young child who believes an unfamiliar testifier.

C1.P8 Let us fix some terminology: I use "warrant" as a genus of epistemic rationality which harbors two species.[2] The first species of warrant is called "justification" and may be generally characterized as a warrant that constitutively depends, for its warranting force, on the competent exercise of a subject's faculty of reason. The warrant for a conclusion-belief on the basis of reasoning is a central example. The second species of warrant is called "entitlement" and does not depend on reason in this manner. The basic warrant for perceptual belief is a central example of entitlement. Entitlement is an epistemically externalist type of warrant that

[1] Coady 1992: 38. See also Shieber 2015: 10ff.; Gelfert 2014: 14ff.
[2] Burge 2003; Graham 2012a; Gerken 2013a, 2013b, 2020a.

partly depends on environmental conditions that the individual needs no cognitive access to. In contrast, justification may be said to be epistemically internalist. One subspecies of justification—discursive justification—is important for scientific testimony since it requires that the subject be capable of *articulating* aspects of the warrant as epistemic reasons (Gerken 2012a). I take "epistemic reasons" to consist of propositional contents that may provide truth-conducive support for believing other propositions, whereas I regard "epistemic grounds" as environmental circumstances that may provide truth-conducive support. I will return to these issues in Chapter 2 and beyond. Now I move on to the main topic of scientific testimony.

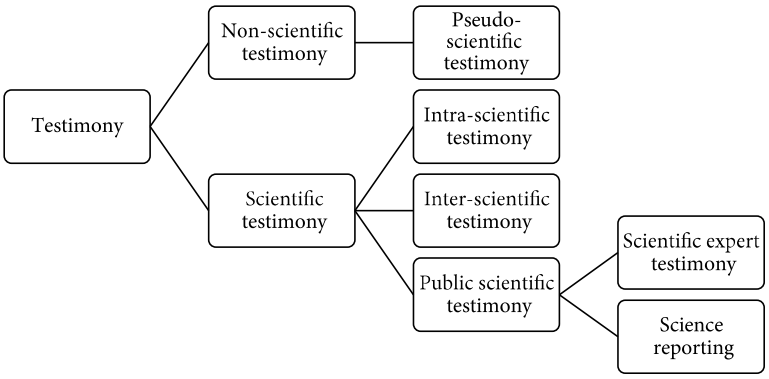
C1.P9 C1.S4 **1.1.b Scientific testimony and its varieties:** It is not a trivial matter to distinguish scientific testimony from other types of testimony. So, to get things moving, I simply present my view, which I will elaborate on and argue for (in Chapter 3.1): What makes a given testimony a *scientific* testimony is the fact that it is properly based on scientific justification.

C1.P10 Scientific testimony is often more formal than everyday testimony, but this is not a defining feature of it. Consider a scientist informing a colleague that the abnormality in their data was due to a defective instrument, or a postdoc emailing the principal investigator that there was a significant effect in the pilot study. Such testimonies exemplify scientific testimony among collaborating scientists that I call "intra-scientific testimony." Yet they are no more formal than the testimony from a realtor who writes her client that the buyer has now signed off on the contract. Likewise, a newspaper may report a study finding that inadequate sleep dramatically increases the risk of traffic accidents in a format that does not differ from a report on policy or sports. Nevertheless, such a report would exemplify another type of scientific testimony—namely, the type I call "public scientific testimony." Yet more specifically, it would exemplify the subspecies that I call "science reporting." Another subspecies of public scientific testimony that I call "scientific expert testimony" occurs when scientific experts testify in some context of scientific communication to laypersons. For example, a particular scientific expert on sleep and sex drive might testify during a public presentation that the two are correlated. The final type of scientific testimony that I will mention is labelled "inter-scientific testimony." It communicates the results of scientific investigation to the general scientific community. This tends to be quite formal since it typically takes the form of publications, such as a journal article.

C1.P11 One thing that all these species and subspecies of scientific testimony have in common is that they are all properly based, in importantly different ways, on scientific justification. In Chapter 3.1, I will argue that this is no coincidence since being properly based on scientific justification is what makes a testimony a scientific testimony. A nicety of this way of looking at things is that *pseudo*-scientific testimony may be derivatively characterized: Pseudo-scientific testimony

is testimony that purports to be scientific although it is not because it is not properly based on scientific justification. Merely non-scientific testimony is also not properly based on scientific justification, but, in contrast with pseudo-scientific testimony, it does not purport to be scientific testimony.

C1.P12 Perhaps a map will be helpful. Figure 1.1 shows the central types of scientific testimony just mentioned:



C1.F1 **Figure 1.1** Types of testimony

I hasten to note that the overview is not comprehensive. There are further subcategories, as well as hybrids and overlaps, among the mapped categories. Consider, for example, an influential scientist who provides expert scientific testimony to a prominent news platform that a classic study has failed to replicate. In some cases, she might be simultaneously testifying to the lay public and her colleagues via a public news channel. Other examples are "breaking scientific news" conferences or press releases in which major findings are simultaneously communicated to the general public and, in a preliminary form, to the scientific community. Likewise, some scientific experts have a side hustle with scientific outreach in popular science media, and their testimonies may therefore be situated in the intersection of *scientific expert testimony* and *science reporting*.

C1.P13 Such hybrid scientific testimonies and borderline cases are important to bear in mind. But they hardly compromise the distinctions insofar as there are reasonably clear and paradigmatic cases of each category. The best way to illustrate intra-scientific, inter-scientific, and public scientific testimony is to consider these categories in turn.

C1.P14 C1.S5 **1.1.c Intra-scientific testimony:** Intra-scientific testimony may be approximately characterized as "scientific testimony from a scientist that has collaborating scientists as its primary audience and which aims to further future scientific

research" (Gerken 2015a: 570). According to this characterization of intra-scientific testimony, it is partly distinguished in terms of, first, its primary audience of (collaborating) scientists and, second, its central aim of furthering future research. These two components are related insofar as it makes sense to communicate to collaborating scientists if one aims to further future research. All in all, intra-scientific testimony concerns science in the making in the daily hustle and bustle of lab meetings, emails, watercooler talk, internal memos, and progress reports, etc.[3]

C1.P15 The characterization is not a reductive analysis which captures all cases. The two components are neither individually necessary nor jointly sufficient for intra-scientific testimony. For example, some cases of intra-scientific testimony obstruct future research or promote past research. However, the characterization captures paradigm cases well enough. For example, it dissociates intra-scientific testimony from standard cases of scientific expert testimony to laymen due to its component concerning the primary audience. Similarly, it dissociates intra-scientific testimony from scientific testimony that is aimed at application in, for example, public policy.

C1.P16 The characterization in terms of primary audience and aim also allows for an initiation of the extended argument that intra-scientific epistemology is not merely a *product of* science but rather a *vital part of* the scientific process. Yet, the characterization remains a rather broad one, and once intra-scientific testimony takes the center stage in Chapter 4, some subspecies of it will be distinguished between. Here, my main aim has primarily been to identify the phenomenon and distinguish it from public scientific testimony, to which I now turn.

C1.P17 C1.S6 **1.1.d Public scientific testimony:** Public scientific testimony is scientific testimony that is primarily directed at the general lay public or select members of it, such as policymakers. Given this broad characterization, there is an enormous variety of public scientific testimony. Public scientific testimony will take center stage in Part III. Here, I will just draw a couple of rudimentary distinctions that I will need to get going.

C1.P18 Some public scientific testimonies are directed at the lay population at large for the purpose of general information. A common example is a scientist's testimony that is quoted in an interview for a public media platform. Such public scientific testimony reflects an important enlightenment ideal of a scientifically informed public (Jasanoff 1990; Kitcher 2011: 85). However, public scientific testimony may also be directed at highly select stakeholders in the layperson population, and these may include political decision makers. A scientific report commissioned by a ministry or scientific expert testimony in legal proceeding are examples.

[3] For a classic and a recent report, see Latour and Woolgar 1979/2013 and Cho 2011.

C1.P19 I draw the general distinction between *scientific expert testimony* and *science reporting* in terms of source and, derivatively, in epistemic terms. What characterizes scientific expert testimony is that its immediate source is a scientific expert in the relevant domain. In contrast, science reporting is typically mediated by someone, such as a journalist, who is a non-expert in the relevant domain. Note that the phrase 'science reporting' may be used in a broad way that denotes discussion of scientific practice, for example, "scientists relocate resources to develop a coronavirus vaccine." But I will be more concerned with a use that qualifies as scientific *testimony* in which a hypothesis or finding is presented as true, for example, "COVID-19 has a longer median incubation period than influenza." Like ordinary testimony, science reporting may be qualified as to indicate the epistemic status of the hypothesis, and I will argue that science reporters should often include such epistemic qualifications (Chapter 6).

C1.P20 To recap, the central difference between scientific expert testimony and public scientific testimony is whether the testifier has relevant scientific expertise. I will argue that scientific expertise standardly involves epistemic expertise. Hence, science reporting has epistemic force since its ultimate source is scientific expert testimony. For example, a science journalist may base their report on a press release, on interviews with scientists, or even by consulting some of the relevant scientific publications. However, given the indirectness of the ultimate source, there are distinctive pitfalls for science reporting that may render it less reliable than scientific expert testimony. For example, even dedicated science journalists tend to be laypersons when it comes to the highly specialized science they report on (Goldman 2001; Figdor 2010, 2018). The additional link in the communication chain is a distinct source of fallibility. Moreover, journalists work in an attention economy in which accessibility, novelty, and other news criteria may trump accuracy and reliability.[4]

C1.S7 **1.1.e Inter-scientific testimony: scientific publications and scientific reports:**

C1.P21 An important type of scientific testimony that I will not thematize, although it will figure occasionally, is inter-scientific testimony. Roughly, this is scientific testimony which aims to communicate the results of scientific investigation to the general scientific community (I owe the label to Dang and Bright forthcoming). A central type of inter-scientific testimony is scientific publications which are, as the name indicates, ways of making scientific findings and theories public. Examples include articles in scholarly journals, academic books, conference proceedings, and so forth. These are public venues, but their primary audience is typically other scientists. Scientific publications are central to the scientific practice and, therefore, governed by both explicit conventions and implicit

[4] Valenti 2000; Miller 2009; Nisbet and Fahy 2015; Figdor 2017; Gerken 2020d.

disciplinary norms. As an example of explicit conventions, consider the *Publication Manual of the American Psychological Association* (American Psychological Association 2009). As an example of fucking implicit disciplinary norms, consider the use of redundant profanity in this sentence. The reason why it is jarring is that redundant profanity violates implicit disciplinary norms of academic writing.

C1.P22 Inter-scientific testimony may include scientific reports which are distinct from science reporting in virtue of being directed to, and often commissioned by, policymakers or other stakeholders in need of scientific assessment. So, scientific reports are typically instances of formal testimony, and for that reason they are subject to more explicit, and often highly idiosyncratic, aims and norms. For example, a scientific report may have to be written in a manner that is apt for basing legislation on it. However, some scientific reports have other scientists as their primary audience. For example, reports from the WHO are resources for health scientists and policymakers alike. Likewise, IPCC reports are also resources for both climate scientists and policymakers. So, while some scientific reports are best classified as public scientific testimony, others are best classified as inter-scientific testimony, and many are in the gray zone between these categories. Likewise, there are gray zones between intra- and inter-scientific testimony. A central difference is that inter-scientific testimony does not have *collaborating* scientists as the primary audience. But social norms and conventions that determine whether another scientist is collaborating in the relevant sense may leave some cases open. Nevertheless, reflection on such norms may provide some principled help in distinguishing intra- and inter-scientific testimony. For example, a scientist may be required to tell a collaborator about the outcome of the pilot study, but she may be required to withhold this information in communicating with non-collaborators from a competing research group.

C1.P23 Both scientific publications and science reports are important types of scientific testimony. In the case of publications, this is because of their dual role of making scientific work public and contributing to future scientific research. In the case of scientific reports, this is because they help apply scientific work to concrete problems. In doing so, they legitimize, and thereby sustain, the scientific enterprise. So, although these types of scientific testimony are not the primary phenomena of investigation here, their importance ensures that they will both make their occasional return.

C1.P24 C1.S8 **1.1.f Concluding remarks on varieties of scientific testimony:** The distinctions drawn and the associated terminology do not come close to a comprehensive taxonomy of scientific testimony. However, they do mark out some important categories, and the brief discussion of the various types of scientific testimony begins to reveal its wide-ranging significance.