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The Epistemic Norms of Intra-Scientific Testimony

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Feel free to contact me for the final publication. MG.*

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Abstract: What is the epistemic position that a scientist must be in vis-à-vis a proposition, p , in order to be in a good enough epistemic position to assert that p to a fellow scientist within the scientific process? My aim is to provide an answer to this question and, more generally, to connect the epistemological debates about the epistemic norms of assertion to the debates about the nature of the scientific process. The question is important because science is a collaborative enterprise based on a division of labor. It has even been suggested that such collaboration is a part of the scientific *method*. However, scientific collaboration depends upon communication between scientists – i.e., intra-scientific testimony.

After distinguishing some different kinds of intra-scientific testimony (Sect. 2), I provide a specific proposal for an epistemic norm of assertion that generally governs such testimony (Sect. 3). I argue that the proposal aligns with the requirements of three scientific virtues – replicability, revisability and accountability (Sect. 4.1-3). The discussion of replicability considers a prominent debate in the social and cognitive sciences (Kahneman 2012). In conclusion, I consider some of the wider questions raised by characterizing scientific collaboration, division of labor and, more generally, scientific method via intra-scientific testimony (Sect. 5).

Keywords: Intra-scientific testimony; scientific collaboration; norms of assertion; division of labor; replicability; revisability; accountability.

1: Introduction. What is the epistemic position that a scientist must be in vis-à-vis a proposition, p , in order to be in a good enough epistemic position to assert that p to a collaborating scientist *within* the scientific process? My aim is to provide an answer to this question and, more generally, to connect the epistemological debates about the norms of assertion to the debates concerning the scientific process.

The question is a hard one, and it requires considerable specification before it admits of an answer. Consequently, the following consists in an effort to specify the question and begin to address it. For as difficult as the question is, it is too important to leave unexamined. Scientific research is increasingly characterized by collaborative efforts that are, in turn, characterized by a high degree of division of cognitive labor (Kitcher 1990, 1993, Strevens 2003). In consequence, communication between scientists – i.e., intra-scientific testimony – has become a vital aspect of the scientific process and method. Scientists rely heavily on the testimony of their peers and collaborators to be able to contribute to science. Indeed, much of the scientists' individual contributions consist in providing testimony to other scientists.

In consequence, intra-scientific testimony is, at least contingently, a crucial part of science. It might even be that intra-scientific testimony figures in a principled characterization of the scientific *method*. But we do not at present understand the nature of intra-scientific testimony well enough to give an accurate characterization of its epistemic roles in the scientific processes.

Of course, scientific testimony *in general* has received a great deal of attention in philosophy of science, in the sociology of science as well as in epistemology. In the epistemology of testimony, issues concerning the epistemic properties of testimony provided by scientific experts to scientific laymen have received much attention (often following Goldman 1999). But testimony that occurs *between*

collaborating scientific experts *within* the scientific process raise equally important issues (for recent work, however, see Vega Encabo 2008, Olsson and Vallinder 2013, Mayo-Wilson 2014, Willholt 2014, Winsberg, Huebner & Kukla 2014, Huebner, Kukla & Winsberg *forthcoming*). The present paper contributes to these debates a concrete proposal for an epistemic norm governing intra-scientific testimony. As such, it explicitly considers contemporary epistemological discussions about epistemic norms in relation to intra-scientific testimony. Integrating relevant work in epistemology to this issue within the philosophy of science may both provide novel insights and give rise to novel questions.

I proceed as follows: In Section 2, I provide a provisional “working categorization” of some kinds of intra-scientific testimony. In Section 3, I propose that an adaption of a general epistemic norm of assertion that may be taken to govern such testimony. In Section 4, I reinforce the proposal by arguing that the epistemic norm aligns with some scientific virtues: Replicability (Sect. 4.1), revisability (Sect. 4.2) and accountability (Sect. 4.3). In Section 5, I outline some preliminary conclusions and some of the novel questions that the discussion has raised.

2: Kinds of scientific collaboration and intra-scientific testimony. Science has evolved to become a highly collaborative enterprise that is characterized by a fine-grained division of cognitive labor (Kitcher 1990, 1993, Strevens 2003, Rolin 2008). It is a crucial, and, I believe defining, feature of expertise that it is domain-specific: To be an expert is to be an expert in a specific domain.

Some collaborative efforts simply derive from the fact that scientists within a discipline collaborate in research groups that are *institutionally organized*. However, the way in which scientists rely on each other goes beyond such institutionalization. Scientists importantly rely on each other’s testimony about both factual matters as well as about normative issues concerning, for example, scientific significance or proper methodology.¹ These kinds of scientific collaboration raise distinctive questions about the epistemic norms governing intra-scientific testimony. I will not pursue a definition of intra-scientific testimony. But it may be loosely characterized as *testimony from a scientist that has other (collaborating) scientists as its primary audience and which aims to further future research*.

This broad characterization dissociates intra-scientific testimony from, for example, expert testimony to laymen. It also dissociates it from scientific testimony that is aimed at application in, for example, public policy. Of course, the characterization remains a rather broad one. But we can approximate some more specific kinds of intra-scientific testimony by recognizing two important and orthogonal distinctions.

The first distinction is between disciplinary and interdisciplinary collaboration. Even though scientific disciplines are in flux and exhibit vague borders, there are still paradigm cases in which we may characterize a given collaboration as interdisciplinary or disciplinary (Andersen and Wagenknecht 2013). If a sociologist works with a biologist on the consequences of, say, a certain hunting policy, the collaboration is paradigmatically interdisciplinary. If she works on the sociological aspects of the policy with another sociologist, it is paradigmatically not. Sometimes, institutionalization will be a reasonable proxy for disciplinarity. But this is far from always the case. Interdisciplinary research is constantly becoming institutionalized in departments, research groups and so forth.

The second distinction is between testimony that constitutes the *output* of a collaborative scientific process and testimony that marks the *input* to such a process. Both kinds of testimony may be regarded as intra-scientific. For even the scientific *outputs* may be aimed rather exclusively at other scientists. For example, a conference presentation is a paradigm of a research output which may be aimed at other scientists and primarily serve the purpose of furthering future research. As such, testimony figuring in articles, conference proceedings and such may be regarded as taking place “within” a broader scientific community. Moreover, intra-scientific testimony may involve conveying results that are well established in one discipline to scientists in another discipline.

¹ For a classic discussion, see (Rudner 1953, Levi 1960). For contemporary debates concerning the ideal of a value-free science, see (Douglas 2009, 2014, Elliot 2011, 2013, Hansson 2007).

Both distinctions are complex in their own right, and the matter is complicated further by the fact that the distinctions are *orthogonal* as indicated by Fig. 1.

Fig. 1. Scientific collaborations

	Disciplinary collaboration	Interdisciplinary collaboration
Output of collaboration	<i>Output of disciplinary collaboration</i>	<i>Output of interdisciplinary collaboration</i>
Input to collaboration	<i>Input to disciplinary collaboration</i>	<i>Input to interdisciplinary collaboration</i>

The categorization indicated by Fig. 1 is coarse-grained, partial and provisional in a number of respects. This is in large part because there are substantive grey zones in the input/output distinction as well as in the disciplinary/interdisciplinary distinction. In consequence, there are brands of scientific collaborations and intra-scientific testimonies that are not accurately represented by these distinctions alone. But despite its coarseness, the provisional categorization presented by Fig. 1 provides some framework for orienting a discussion of the epistemic norms of intra-scientific testimony. As mentioned, there are paradigm differences between my testimony to my research group and my testimony to the wider scientific community. Likewise, there are paradigm differences between my communicative collaboration with my disciplinary peers and scientists from other fields. So, we may simply focus on paradigm cases that fall under each category. Thus, grey-zone cases and cases not captured by the working categorization will not be accounted for. Nevertheless, a less than comprehensive account of paradigm cases may give us some important bearings. In particular, it may enable us to begin to understand the factors that determine whether an intra-scientific testimony meets or violates the distinctive epistemic norms that govern it. Moreover, even a partial account may enable us to appreciate the relationship between some commonly recognized scientific virtues and the epistemic norms of intra-scientific testimony.

So, although it should be reemphasized that the categorization is rough and provisional, it does indicate some of the paradigm forms of scientific collaboration that are relevant for the study of intra-scientific testimony. Hence, I will use it as such – as a rough provisional categorization that serves to structure an initial discussion of the epistemic norms governing testimony.

I will focus on the lower row of Fig. 1. That is, I will focus on paradigm cases of intra-scientific testimony as characterized by their aim of conveying something to a collaborator with the aim of producing *further* research. As a practical proxy for such “input” cases, we may use *pre-publication* communication between collaborating scientists. This proxy has the advantage of providing a fairly straightforward, albeit not entirely accurate, criterion for intra-scientific testimony that aims to contribute to an output beyond the content of the testimony. However, given the crudeness of this proxy, the specific aims of the intra-scientific testimony in question must be taken into account and I will return to this issue in Section 4.

Considering intra-scientific testimony that marks an *input* to the scientific process (rather than the *output* of this process) will raise some novel questions. Moreover, this focus reflects the idea that intra-scientific epistemology is not merely a *product of science*. Testimony from one scientist to another is often a constituent *part of* the scientific process rather than the outcome of the scientific process. As such, intra-scientific testimony is subject to distinctive epistemic requirements. Or so I will argue.

3. Epistemic norms and epistemic warrants. In this section, I will introduce some of the epistemological apparatus that I will apply to the case of intra-scientific testimony.

There are a number of epistemic norms of assertion on the market. I will adopt a species of my “Warrant-Assertive Speech Act” (WASA) norm which may be taken as a development of Grice’s Maxim of Quantity (Gerken 2012, 2014, Grice 1989).² This account is apt for the present purpose in virtue of exhibiting a number of properties that aligns well with commonplace assumptions in the philosophy of science. For example, the term ‘warrant’ is here used to denote a generic property of epistemic rationality which is *non-factive* and *gradable* (Burge 2003, Gerken 2013a, b).³ These are properties that are commonly attributed to scientific justification. Moreover, since warrant is the genus of epistemic rationality, it may be taken to include several distinctive species (Burge 2003, Gerken 2012, 2013b, *forthcoming a*). The assumption that there are different *species* of warrant aligns well with the idea that scientific knowledge and justification are not merely more certain than their non-scientific counterparts but rather *different in kind*. Indeed, scientific justification and knowledge are not invariably more reliable than their non-scientific counterparts. For example, a scientist’s hypothesis that the number of tropical hurricanes will increase over the next fifty years is hardly more reliable than her non-scientific hypothesis that there is coffee in the cup in front of her. Even if the scientist may be said to know the scientific hypothesis in question, she may know the ordinary hypothesis at least as well (in the sense of being at least as reliable). In short, ordinary knowledge of extra-scientific facts can be just as reliable as scientific knowledge.

Of course, acknowledging differences in kind of warrant is compatible with the idea that scientific warrant comes in degrees. Indeed, both the idea that scientific warrant is gradable and the idea that there are different species of warrant have important ramifications for the epistemic norms of intra-scientific testimony. Let us consider them in turn.

To consider the property of gradability of epistemic rationality, consider the generic “Warrant-Assertive Speech Act” norm – WASA, for short:

WASA

In a conversational context, CC, in which S’s assertion that *p* conveys that *p*, S meets the epistemic conditions on appropriate assertion that *p* **(if and) only if** S’s assertion is appropriately based on a degree of warrant for believing that *p* that is adequate relative to CC.

The central characteristic of WASA is the claim that S’s conversational context determines the degree of warrant for believing that *p* that S must possess in order to meet the epistemic conditions on appropriate assertion that *p*. In some contexts, a quite modest degree of warrant will do. Other conversational contexts require a higher degree of warrant (Gerken 2012).⁴

Given WASA, the specification of the conversational context, CC, is very important. I take it to be specified by the speaker’s reasonable beliefs or presuppositions about a set of context-determining parameters which include the following (Gerken 2012):

- (i) alternative assertions
- (ii) the availability of evidence for the asserted content
- (iii) the urgency of conveying the asserted content

² Whether the norm in question is Gricean is debated (see Benton *forthcoming*). But since the matter is exegetical, I will set it aside here.

³ In contrast, knowledge norms are *factive* (Williamson 2000). On the other hand, a number of non-factive alternatives do not clearly appeal to a *gradable* epistemic property (Douven 2006, Lackey 2007, Kvanvig 2009). Here I will only give a positive case for the view that an alternative norm governs intra-scientific testimony. For my negative case against knowledge norms, see (Gerken 2011, 2012, 2014, 2015 *forthcoming b*).

⁴ The parenthesis is due to some complications with the sufficient condition that need not concern us here. I have allowed myself a slight modification of my 2012 formulation in order to deal with certain cases of implicature that are also largely orthogonal to the present concerns.

- (iv) the relevant stakes
- (v) social roles and conventions.

I will argue that the final of these context-determiners, (v) social roles and conventions, is especially important for understanding the epistemic norms governing intra-scientific testimony. This is in part because the nature of scientific practice is intimately tied to certain social roles and conventions of the scientific procedure. Indeed, some social roles and conventions may be constitutive of scientific practice. We regard S as a scientist and S* as a non-scientist in part because S plays a certain role in the scientific community. This role explains why S is subject to certain norms and S* is not.⁵ Among these norms we find the epistemic norms that govern S's assertions in intra-scientific collaboration. For example, it is reasonable to suppose that if S is in a conversational context where she communicates a scientific result, *p*, that her colleagues will rely on, then she must have a high degree of warrant for believing that *p* is true. In contrast, if S is in a conversational context in which she merely asserts *p* to laymen at a dinner party, a lesser degree of warrant may be acceptable.⁶

Let us turn from the property of gradability of warrant to the idea that there are different *kinds* of warrant and that some of them are especially important in science. Following Burge, I distinguish between externalist species of warrant called 'entitlements' and internalist species called 'justifications' (cf. Burge 2003, Gerken 2011, 2012, 2013b). I have argued elsewhere that both internalist and externalist species of warrant play a role in the epistemology of testimony (Gerken 2013b, *forthcoming a*). But I did not address the question as to the nature of intra-scientific warrant. However, others have argued that science requires a sort of trust among scientists (Hawley 2012, Wilholt 2013, Frost-Arnold 2013). I am sympathetic to the idea that intra-scientific testimonial entitlement and trust play important roles in scientific collaboration (but see Fricker 2002, Douven and Cuypers 2009). At least everything that I will argue is compatible with the idea that recipient of intra-scientific testimony may have to trust her fellow scientists' testimonies and that she may only acquire entitlement to believe testimonies (Gerken 2013b). However, in the present investigation, I shift the focus from the requirements and entitlements of the *recipient* to the epistemic norms that govern the *provider* intra-scientific testimony.

What I will argue is that a scientist who provides intra-scientific testimony must, at least paradigmatically, possess a kind of justification for believing what she testifies.⁷ This is a more demanding requirement than has typically been emphasized. Justification (internalist warrant) is typically distinguished from entitlement (externalist warrant) by a requirement that the justified agent has *access* to the grounds for the warrant. In consequence, an agent who is justified in believing that *p* has access to some reasons for her belief that *p*. The epistemological internalist-externalist debate remains a major issue.⁸ Here my key assumption is that many conversational contexts require not only a justification but a sub-species of justification that I label 'discursive justification.' Discursive justification requires that "...S is able to *articulate* some epistemic reasons for believing that *p*." (Gerken 2012: 385 – emphasis added).

This articulability requirement on discursive justification renders it a demanding sub-species of justification – especially when compared to the contemporary emphasis on trust and entitlement in intra-scientific discourse. The ability to articulate reasons for believing that *p* goes beyond the ability to access such reasons for oneself. Yet, it seems plausible that in many conversational contexts, one meets the epistemic conditions on assertion only if one is capable of "backing up" one's assertion by explicit

⁵ This claim does not entail any substantive social constructivism about the nature of science. It is compatible with the idea that there are objective marks of scientific practice.

⁶ This comparative claim should not be taken to suggest that I think that there are generally low epistemic requirements for scientists who *qua scientist* provide testimony to laymen. On the contrary, I think that such scientific testimony generally requires a high degree of warrant.

⁷ I suspect that there will be some cases in which this requirement is too harsh.

⁸ For my views, see Gerken 2012, 2013a, *forthcoming a*. I here simplify a bit insofar as I here take accessibilism as a proxy for epistemic internalism. The more complex story is in *forthcoming a*.

reasons. Such contexts may be called ‘discursive contexts,’ and I venture to propose that the context in which intra-scientific testimony takes place is, at least paradigmatically, a kind of discursive context. Typically, a scientist who testifies that p to a specific colleague or to a scientific community is required to be able to articulate reasons for believing that p . I will motivate this assumption below.

In the present framework, the general epistemic norm, WASA, has a sub-species – the Discursive Justification-Assertion account (DJA for short). DJA that governs discursive conversational contexts (Gerken 2012):

(DJA)

In the discursive conversational context, DCC, in which S ’s assertion that p conveys that p , S meets the epistemic conditions on appropriate assertion that p **(if and) only if** S ’s assertion is appropriately based on a degree of discursive justification for believing that p that is adequate relative to DCC.

My proposal is that the conversational contexts characteristic of intra-scientific testimony are paradigmatically but not invariably discursive contexts. Hence, the kinds of intra-scientific testimony under discussion are typically governed by something like DJA. Of course, a further specification of the distinctively *scientific* context may ultimately be required. If this turns out to be the case, a yet more specific sub-species of the epistemic norm may be required. But I will adopt DJA as a starting point.⁹

At least, DJA captures the basic assumption that there are important normative constraints on the *provider* of intra-scientific testimony. In particular, it captures the idea that a scientist who provides intra-scientific testimony must be able to articulate epistemic reasons in support of its content. In paradigm cases, a scientist who provides intra-scientific testimony as a contribution to the scientific process in, for example, a research group may be subject to distinctively *epistemic* criticism if she is unable to back up her testimony with any reasons.

Of course, concrete citable examples of intra-scientific testimony between scientists in the intra-scientific process prior to publication can be hard to come by. Typically, there is no citable track-record of pre-publication communication.¹⁰ However, I will provide a couple of concrete cases that are reasonably representative of familiar classes of intra-scientific testimony.¹¹

A quantitative study on intra-scientific trust reports the following exchange between a theoretician and an experimenter: “...‘Look, why don’t you try this new thing’ and they’ll reply something like, ‘No, that’s way too hard’. ‘Why?’ I’ll ask. ‘You can’t do that to the coils’. ‘Ah, ok’.” (Reyes-Galindo 2014: 740). For the present purpose, the *structure* of the exchange is illuminating. In requesting an explanation, the recipient presupposes that the testifier possess reasons to back up her assertion. The reasonableness of this presupposition is evidenced by the fact that the testifier proceeds to articulate such reasons. Reyes-Galindo’s quantitative study concerns large-scale collaboration in physics but similarly structured intra-scientific exchanges are natural in many kinds of interdisciplinary research groups.

Something similar may occur in proposing a study design. An example of such a case occurs Ariely’s *Predictably Irrational* which includes illustrative anecdotes from various stages of collaborative research. Ariely reports: “On one of my visits to Professor Frenk’s office, I proposed a theory of explaining how a certain stage of epilepsy developed, and included an idea for how one might test it in rats” (Ariely 2008: *xv*). The example illustrates a familiar situation in the early stages of intra-scientific collaboration – namely, that of articulating sufficient justification (the theory) for a hypothesis to direct

⁹ For a similar proposal, see (McKinnon 2013). She takes her “supportive reasons” norm to be general whereas I take DJA to be a species of the more general norm WASA (Gerken 2012). Since I will only argue that the ability to provide epistemic reasons is *paradigmatically* governing intra-scientific testimony, I focus on the more modest DJA.

¹⁰ For historical perspectives, see Shapin 1994 and Kusch 1999. See also Ermeren and Garssen 2008.

¹¹ Thanks to Martin Kusch, Axel Gelfert and the editors for correspondence on this point.

resources to its testing. In this case, the testifier must also provide discursive justification for the assumption that the proposed study design is likely to provide relevant evidence.¹²

Another standard case of intra-scientific testimony is that between a statistician and a research group. This is a regular, indeed institutionalized, division of cognitive labor in the social and cognitive sciences. Here is an excerpt from an email that I received from a collaborator responsible for the data analysis for an empirical paper: “No significant correlation between CRT score and inclination to attribute knowledge in either the Study 3 (sapphire/diamond) thief contrast or jewel contrast conditions” (personal correspondence cited with permission). This piece of testimony that the conditions yielded null results was backed by discursive justification. Although it was not articulated, the testifier was in a position to provide the statistical analysis that justified the claim. On this occasion, we included both the claim and its justification in the article because we opted to discuss the nulls (Gerken and Beebe *forthcoming*, Sect. 6). But in many cases, the testimony that there were no significant effects would serve to *terminate* work on the conditions in question. The key point, however, is that the testimony was in fact backed discursive justification in the form of a statistical analysis that the testifier could articulate upon request. Had the testimony been based on eyeballing the data, the testifier could have been faulted. From a more institutional point of view, a statistician’s job is to run statistical analysis that can serve as discursive justifications for certain claims. Even when the testimony is intra-scientific, this is typically the epistemic norm that the testifier must be meet since the testimony often serves to direct ongoing research.

DJA also captures the idea that the strength of the reasons that the testifier must be able to articulate depends on the specific intra-scientific context in question. If a statistician’s claim about significance just addresses a research group member’s curiosity about a peripheral aspect of the study, a very low degree of discursive justification (and perhaps even an entitlement) may be acceptable. So, DJA is apt to account for the fact that different kinds of intra-scientific testimony come with different epistemic requirements.

Recall, from Fig. 1, the category of intra-scientific testimony that constitutes an *output*. Such testimony often demands that the relevant reasons are *in fact* articulated. A mathematician does not only report a theorem but also a proof. A psychologist does not only report a finding but also the study design and methodology. In contrast, intra-scientific testimony that merely constitutes a *contribution* to ongoing collaborations may only require that the testifier be able to articulate the reasons in question. Whether this is the case depends on more specific details of the context. For example, the matters of urgency and availability of further evidence may bear on the exact epistemic requirements on the testifier. But facts about her role in the collaboration remain paramount. If, for example, the testifier is a member of a research group and, therefore, readily available to elaborate if required, then it may be enough that she *is able* to articulate the reasons supporting the testimony. Consider, as an example (loosely based on anecdotal evidence), that an anthropologist, who is a member of a research group on water resource policy, provides intra-scientific testimony about a nomadic tribe’s traditional rules concerning rights to water. If the anthropologist is readily available, it may be enough that she is able to articulate the discursive justification. But if she is about to embark on further field studies, she may be required to articulate the justification. So, although the output testimony should not be required to have stronger epistemic support than what is available within the scientific process that leads to it, it may be subject to more demanding dialectical requirements. I elaborate on the ramifications of this issue below in Sect. 4.1.

¹² Similar popularizing books that report on the origin of research contain similar anecdotes in which a claim or suggestion is accompanied by a justification, see e.g. (Sunstein 2009: 26). Kahneman reports that even in the context of discovery, the exchanges with Tversky were “critical and argumentative” (Kahneman 2011: 6). Likewise, Kahneman reports that an early idea was raised as “...a vague thought, not as a discovery” (ibid. 278) which is, according to DJA, appropriate given that it was at the time inadequately justified.

These considerations make it clear that a closer specification of the epistemic requirements of a given intra-scientific testimony requires a more fine-grained specification of the context and the communicative aims of the testimony. I will initiate such a specification in the next section. In this section, I have simply suggested that DJA is, in a wide array of cases, an apt epistemic norm of assessment of intra-scientific testimony insofar as it captures two key ideas. The first idea is that the scientist who provides intra-scientific testimony must possess a distinctive *kind* of warrant – namely, discursive justification. The second idea is that the *degree* of discursive justification required depends on the specific context in which the intra-scientific testimony takes place. DJA captures both ideas in virtue of recognizing that the context in which intra-scientific testimony takes place is typically one in which the testifier must be able to articulate the scientific basis for her testimony.

4. Scientific virtues and the aims of intra-scientific testimony. As mentioned, the epistemic requirements on intra-scientific testimony are partly determined by its communicative aim. So, a specification of the epistemic requirements on intra-scientific testimony calls for a specification of the *aims* of intra-scientific testimony.

To provide the required specification is a tall order. Scientific communication and collaboration are extremely varied and complex affairs. Indeed, it is an important task for empirical studies of science to identify and analyze the various aims of intra-scientific testimony.¹³ However, given the provisional categorization above along with the characterization of intra-scientific testimony and DJA, a number of fairly general things may be noted.

First (and foremost), the specific aims of intra-scientific testimony should be taken to be at least somewhat derivative from the overarching aim of the scientific process that it is part of. This issue is, of course, a major debate in the philosophy of science. For the present purpose, I assume a robust realism according to which the aim of scientific theories is to provide (approximate) true or accurate representations of the extra-mental reality – including its unobservable parts (for an overview, see Godfrey-Smith 2003, Ch. 12). However, a good deal of what I will argue may be compatible with assuming an anti-realist aim such as, for example, empirical adequacy (van Fraassen 1980).

Second, the aims of intra-scientific testimony vary with the kind of scientific investigation within which the testimony takes place. A statistician telling a developmental psychologist that some measure of a behavioral response is statistically significant is a different matter from a sociologist who makes a broad value-laden methodological recommendation to colleague. Such differences should be reflected, somehow, in the epistemic norms governing the respective testimonies. Fortunately, DJA may accommodate this desideratum given that testifier and audience *roles* partly determine the degree and kind of epistemic position required of the testifier. As mentioned, differences in the roles of the scientific process may yield a difference in terms of the nature and strength of the reasons that the testifier must be able to articulate.

Third, the epistemic norms governing intra-scientific testimony should be responsive to both general and discipline-specific scientific virtues. This point may be motivated, in part, by reflection on the relationship of scientific virtues and norms governing intra-scientific testimony in general. Assume for the sake of argument that simplicity is a scientific virtue insofar as it plays a role in theory-choice (Sober 1981, 2009). This assumption plausibly yields a concomitant normative constraint on the content of intra-scientific testimony to the effect that it is only as complex as contextually required. If a scientist just needs one data point in order to run her analysis, her colleague should ordinarily simply testify to that effect without digressions about general methodology – unless it is especially relevant to

¹³ Computer simulations may also be useful and I think that the results in (Olsson and Vallinder 2013) are broadly congenial to the present approach. For example, they note that a requiring a threshold of certainty should be rejected for “an investigative and communicative process extending over a finite period of time” (Olsson and Vallinder 2013: 2571). Moreover, the parameters that Olsson and Vallinder vary – e.g., time for available inquiry – align well with the mentioned determiners of conversational context. I postpone a fuller comparison to another occasion.

the case at hand. Here we may find a natural analog of the Gricean Maxim of Quantity: “do not make your contribution more informative than is required” (Grice 1989: 26). By analogy, it is plausible that scientific virtues that are more directly truth-conducive than simplicity may yield concomitant constraints on the *epistemic* norms governing intra-scientific testimony.

This third point is connected to the first point because most scientific virtues are virtuous in virtue of being conducive to the overarching aim of science. Given this connection, we may pursue our investigation by considering how DJA fares with respect to various scientific virtues.

Of course, it is debated which properties of scientific theories and methods qualify as scientific virtues. But the list of candidates includes explanatory power, replicability, coherence with other theories, predictive accuracy, ability to unify different areas, revisability, parsimony etc.¹⁴ In consequence, we may consider DJA in connection to some accepted candidates of broad virtues. So, I will focus on the two scientific virtues of replicability and revisability. They are fairly uncontroversial and fairly general. Furthermore, they figure in natural and many social and human sciences.¹⁵ Hence, replicability and revisability are also among the *candidates* for aspects of a characterization of the scientific method. I will supplement the discussion of these two virtues with the virtue of *accountability* which is less commonplace in the debates concerning theory-choice but important for the ethics of scientific expertise (Douglas 2009, Winsberg, Huebner & Kukla 2014, Huebner, Kukla & Winsberg *forthcoming*).

Considering these more specific scientific virtues exemplifies how DJA may take them into account and thereby help us articulate more specific epistemic requirements on scientists who provide intra-scientific testimony. My account is not a revisionist one. Rather, it aligns with much of the existing practice in scientific collaboration. So, along the way, I will make reference to, and indeed appeal to, aspects of scientific practice. For example, I will approach the virtue of replicability by considering a prominent debate in the social and cognitive sciences due to (Kahneman 2012).

My aim in the three following subsections, then, is not to contribute to an account of the various scientific virtues. Rather, I merely seek to provide abductive motivation for assuming intra-scientific testimony to be paradigmatically governed by DJA. I do so by invoking fairly uncontroversial assumptions about the virtues in question to show how these assumptions align with DJA.

4.1. Replicability. In the social and cognitive sciences, recent years have witnessed heated debates about replicability and the lack thereof. A prominent example is Kahneman’s open letter to researchers in the branches of the cognitive and social sciences who study social priming (Kahneman 2012). Kahneman calls for a “methodological protocol” to address, among other things, “general concerns with replicability that affect many disciplines, multiple reported failures to replicate salient results” (Kahneman 2012).

Kahneman’s open letter has generated heaps of discussion (see Nature News 2015 for a recent report). As a humble philosopher, I will not attempt to settle any of these grand debates within specific disciplines. I note them to underscore the significance of replicability as a scientific virtue. While Kahneman has been criticized on various accounts, the assumption that replicability is an important scientific virtue in the social and cognitive sciences has not.

Consider, therefore, what the requirement of replicability in turn requires of providers of scientific testimony. If a scientist’s contributions must be replicable, the epistemic reasons for her conclusions must be readily available to potential replicators. But this is only the case if she is able to articulate those reasons. But that is to say that she must have some degree of discursive justification. In

¹⁴ It is very controversial whether anything like a characterization of science can be cast in terms of some combination of these candidate scientific virtues. But the virtues may be taken as fallible marks of science rather than as a criterion.

¹⁵ Replicability and revisability are hardly general enough to figure in a *criterion* of science. For example, the notion of replicability does not have a straightforward application in a field such as history. In mathematics, it is even less clearly applicable. To check a proof is only to replicate it in some extended sense of ‘replicate.’

the social and cognitive sciences, the discursive justification will often amount to a rationale for the study design and methodology, a data set and some central claims about it that are justified by a statistical analysis (see, e.g., the Publication Manual of the American Philosophical Association 2009). Each of these aspects may serve as a partial epistemic reason in discursive justification for the main hypothesis. Early in the collaborative process and especially in the context of discovery, less discursive justification will often do. A member of a brainstorming research group may only have to sketch her reasons for the assertion that a particular study design may uncover important evidence bearing on a hypothesis of interest. But in each case, we have a fairly clear area of application for DJA. Of course, the differences between various areas of science will render the various discursive contexts rather different. Perhaps the contexts will be so different that specifying a general mode or standard of articulability is not feasible. But in connection with the debates in the social and cognitive sciences, it is worth noting that Kahneman's proposed protocol of a "daisy-chain of replications" would require that raw data and methodological aspects of the study designs be readily available (Kahneman 2012).

So, insofar as a scientist should be responsive to the virtue of replicability, this should be reflected in the requirements on scientific testimony. Although I am only seeking to provide a framework for specifying these requirements that will have to be applied to particular areas, we may note a few fairly general points. One such point invokes the distinction (from Sect. 2) between testimony that marks scientific *output* and intra-scientific *contributions*, respectively. These different aims typically yield different *discursive contexts*. So, according to DJA, the epistemic requirements on the speaker are different as well.

As noted above, the discursive context of testimony that amounts to a scientific output may often come with a strong articulability requirement. Apart from the familiar distinction between the context of scientific discovery and the context of scientific justification, we must recognize a "context of scientific presentation."¹⁶

When presenting scientific results, the justification for them must typically not merely be articulable but articulated. However, things are a bit subtle here because the requirements on output testimony may be said to be stronger than those on the intra-scientific testimony in a dialectical sense but not in an epistemic one. It would be unreasonable to require that the scientist must possess more discursive justification for the output testimony than is available within the scientific investigation.¹⁷ On the other hand, in broadcasting a scientific result to the world, it is typically not enough that the scientist simply *is able* to articulate epistemic reasons for the content of her testimony. Rather, it is frequently required that those reasons are in fact *articulated* along with the testimony. So, while the *epistemic* requirements on output testimony are not more demanding than the epistemic requirements on intra-scientific testimony, the *dialectical* requirements on output testimony may be stronger. In practice, this amounts to a requirement that one specifies one's data and methods so precisely that a competent colleague is able to attempt a replication on the basis of the specification. However, this dialectical requirement on output testimony reflects back on the epistemic requirements on intra-scientific testimony. In preparing output testimony, scientific collaborators must be able to articulate reasons that typically have to be explicated in the "context of presentation." But this, in turn, requires that the intra-scientific testimony is backed by discursive justification, and this is a reason to assume that it is standardly governed by DJA. This requirement is by no means a revisionist suggestion. Rather, it is deeply integrated in publishing practices. In many fields, a journal article standardly requires a critical discussion of the main findings that explicates why they justify the central conclusions (again, the APA Publication Manual 2009 provides a concrete example).

An important dimension of Kahneman's plea for replicability may be understood as insisting that the contemporary scientific practice in social and cognitive science has begun to violate this epistemic norm on scientific testimony. What I have emphasized in addition is that this does not merely

¹⁶ For Reichenbach's famous distinction and recent work on it, see (Reichenbach 1938 and Schickore and Steinle 2006).

¹⁷ Thanks to an anonymous referee on this point.

apply to the status of the scientific output. A variety of the concern pertains to testimony that constitutes a contribution to a collaborative scientific process. This is not to say that there are no relevant differences, of course. In the case of intra-scientific testimony that aims to *contribute* to a collaborative process, the discursive context is different. Hence, the epistemic requirements on the testifier are, according to DJA, different. In particular, the articulability requirement on the testifier may be weakened somewhat. The division of labor in scientific collaboration typically renders it infeasible to articulate the relevant reasons for upholding the content of one's intra-scientific testimony. In the case of *interdisciplinary* collaboration (cf. Fig. 1 above), the reason for this may well be that the recipient may be incapable of appreciating these reasons. At least in some kinds of interdisciplinary collaboration, one's collaborators may be akin to laymen with regard to one's own area of expertise. But, as emphasized above, the discursive justification which must typically be articulated in scientific reports must be present in the work that is reported.

So, even if the articulability requirement is (dialectically) weakened in these discursive contexts, this is not evidence to the effect that there is no such requirement on intra-scientific testimony. On the contrary, in the intra-scientific case, the testifier is typically required to be able to articulate the epistemic reasons that support her testimony. As mentioned, one reason for this is that the dialectical requirements on scientific output in the context of presentation yield requirements on the kind of justification that figures within the scientific process. So, reflection on the demands of replicability provides partial but important abductive evidence for assuming that intra-scientific testimony is paradigmatically governed by a norm such as DJA.

4.2. Revisability. A scientific hypothesis must very often be revised or calibrated during the scientific process. To see the significance of this fact and connect it to the foregoing remarks, let us turn to the issue of revisability which is another candidate of a quite general scientific virtue. Roughly, the virtue of revisability amounts to the idea that scientific hypotheses should be articulated as to be revisable in the light of further evidence or given a clash with other hypotheses. The idea that scientific hypotheses should be, in principle, open to revision and that pursuing such revisions is an important part of scientific practice may be motivated by broadly Popperian considerations.¹⁸

Given the plausibility of revisability as a fairly general virtue of scientific theories and hypotheses, let us consider how this issue relates to intra-scientific testimony. Perhaps, the first thing to notice is that rationally revising a hypothesis involves revisiting the reasons for upholding it in the first place. But this, in turn, seems to require that one has access to those reasons. Thus, the basic demand of revisability yields a requirement that a scientific hypothesis is access-justified – i.e., that its proponent has access to the epistemic reasons for it.

What does this point have to do with intra-scientific testimony? To see the relevance, let us consider the requirements of rational revisability in *communal* hypothesis-revision of the sort that is characteristic of scientific collaboration (here I continue Gerken 2013b, Sect. 3.2 and *forthcoming a*).

Consider three collaborating scientists S^1 , S^2 and S^3 . Each of them provides testimony in favor of a hypothesis that bears on their joint research. Unfortunately, the three hypotheses form an inconsistent hypothesis set. Assume, for example, that S^1 testifies that the hypothesis that p is true, that S^2 testifies that the hypothesis that p entails q is true and that S^3 testifies that the hypothesis that non- q is true. If the collaborators come to realize that they hold jointly inconsistent hypotheses, they ought to engage in communal revision of the hypothesis set. But if each of the scientists is merely entitled and

¹⁸ It is important, however, that appealing to such broad motivations does not commit the proponent of revisability to the more radical or idiosyncratic aspects of Popper's falsificationism. For one thing, the idea of revisability is rarely taken to amount to anything like a demarcation criterion. For another, one may require that a hypothesis or theory be articulated as to be revisable without any commitment to the idea that there is no inductive confirmation but only corroboration (Popper 1959, 1963). For an account of how group-level considerations bear on a broad Popperian picture, see (Rowbottom 2011, 2013).

lacks any access to the grounds of her hypothesis, the group is in a bad position to determine which hypothesis should go.

In contrast, if each of the collaborators is *discursively* justified, they can not only access but also articulate their reasons for their respective hypotheses. By doing so, they improve their epistemic basis for making a truth-conducive communal revision. In this manner, *discursive* justification appears to be of considerable epistemic importance. What enables the group deliberation to revise the hypothesis set in a truth-conducive manner is that the reasons for and against the hypotheses in question may be set forth. This is particularly so if there are asymmetric defeasibility relations between the reasons for the various hypotheses. For example, it may be the case that some of the reasons for the hypothesis that p defeat the reasons for the hypothesis that non- q . Yet it may be that the reasons for the hypotheses that non- q do not defeat any of the reasons for the hypothesis that p . Ceteris paribus, the hypothesis that non- q should go in such a case. But unless the reasons for both hypotheses may be set forth, the group will not be in a good position to reach that conclusion. To make this schematic example a bit more concrete, assume that the scientists are economists who rely on three different models as justifications for their respective hypotheses. It may be that the assumption p which is justified by S^1 's model, M^1 , shows that a central idealization in S^3 's model, M^3 , is untenable. Everything else being equal, the scientists will have a defeasible reason to abandon the hypothesis q . But, of course, they will only acquire this reason if S^3 is able to articulate the justifying model, M^3 , well enough to make the problematic idealization evident.

Thus, the general scientific virtue of communal revisability involves a concomitant requirement to possessing discursive justification for the content of one's intra-scientific testimony. So, the considerations about revisability reinforce the idea that DJA paradigmatically governs intra-scientific testimony. Note that, as in the case of replicability, the epistemic requirement is on the *testifier* and not on the recipient. Everything that I have argued is compatible with the idea that a scientist may trust a collaborator and only become entitled in believing what she is told. In interdisciplinary collaboration, this may be practically necessary (Hawley 2012, Wilholt 2013). For in this case, the scientist may be a layman with regard to her collaborator's domain of expertise. Indeed, it may be that a particularly strong form of discursive justification is typically required by testimony that contributes to *interdisciplinary* collaboration (cf. the lower right box of Fig. 1). For it may be that the testifier in some such contexts must possess discursive justification that the audience can appreciate or that she can explain to the audience. In many collaborative contexts, such an audience-relative comprehensiveness requirement may be too strong. On the other hand, it seems problematic to flatly assert something that one knows to be inconsistent with one's collaborators' hypotheses if one does so for reasons that one is well aware that they cannot appreciate. So, in an exploratory spirit, I raise the option that interdisciplinary intra-scientific testimony may come with especially demanding discursive requirements on the testifier's discursive justification.¹⁹

These points do not compromise the idea that entitlement and trust play important roles in intra-scientific testimony (Hawley 2012, Wilholt 2013, Frost-Arnold 2013). But reflection on replicability and revisability strongly suggests that this point must be counterbalanced by recognizing that discursive justification plays an important role as well. In particular, the distinctive epistemic demands on the intra-scientific testifier are illuminated by reflection on these scientific virtues.

4.3. Accountability. The idea that scientists must be accountable differs from the requirements of replicability and revisability. Whereas the former are among the candidate characteristic features of science, the requirement of accountability may be better seen as an important desideratum. This is not to diminish its significance. On the contrary, accountability is extremely important for both ethical and epistemic reasons. Indeed, its importance is increasing due to the increase in collaborative science.

¹⁹ Here we may have a range of cases in the philosophy of science that may reflect light back on the epistemology of the epistemic norms of assertion. But the fact that the direction of illumination is bidirectional is not a bad thing.

Recent work on these issues by Winsberg, Huebner and Kukla focuses on the significance of accountability in radically distributed scientific collaboration: "...radically epistemically distributed scientific collaborations produce a problem of accountability" (Winsberg, Huebner & Kukla 2014. See also, Huebner, Kukla and Winsberg *forthcoming*). Their basic assumption, which I share, is that "...it is crucial that scientific claims be backed up by accountable authors. Hence accountability, in a scientific context, is simultaneously an ethical and epistemic notion" (Winsberg, Huebner & Kukla 2014). Note that this assumption may support the present proposal that something like DJA standardly governs scientific testimony. At least, Huebner, Kukla and Winsberg also emphasize the importance of *discursive* justification: "An author must be able to justify and vouch for the truth of her claims, defend her products when challenged, and retract her claims when she cannot defend them in light of criticisms or new information." (Huebner, Kukla and Winsberg, *forthcoming*).

One aspect of the problem that Winsberg, Huebner and Kukla address is that when the epistemic labor is radically distributed, it becomes extremely difficult to assign authorship and, thereby, accountability for the output of the research. Since radically collaborative scientific collaboration is increasingly commonplace, the issue is increasingly pressing. Here I will contribute to a piece of the puzzle by considering the ramifications of the desideratum of accountability for intra-scientific testimony that *contributes* to the scientific process (the lower row of Fig. 1).

In radically distributed scientific collaboration, no single individual may have even a basic appreciation of all of the epistemic reasons that underwrite the scientific output. This is especially so when the collaboration is interdisciplinary (Andersen and Wagenknecht 2013, Huebner, Kukla and Winsberg *forthcoming*). In such cases, the demands associated with the general accountability desideratum may well fall upon the individual contributors in a piecemeal manner. Metaphorically speaking, one rotten apple may ruin the basket of mixed fruits.

I suggest, then, that DJA captures one important aspect of the accountability requirements that collaborative science generates. For DJA distributes at least parts of the accountability by setting forth a strong epistemic requirement on the individual testifiers. According to DJA, the individual who provides testimony that contributes to a scientific collaboration must be able to provide contextually adequate epistemic reasons for her testimony.

Moreover, DJA captures the idea that the specific role of the individual in the process and the reasonably presupposed context of the testimony determine the strength of the epistemic reasons that she must possess. For example, a laboratory assistant who has had no role in developing the study design may provide testimony that the results are so-and-so without having a great degree of discursive justification for believing that so-and-so. (But if she is entirely unable to articulate any epistemic reasons whatsoever, she is typically violating an epistemic norm.)²⁰ In contrast, the principal investigator of a research group who reports the same results at a conference must be able to articulate quite strong epistemic reasons in support of her testimony. Note also that the strength of the reasons required plausibly varies with some of the other parameters – stakes, urgency etc. – that determine the conversational context. So, DJA captures some fairly standard considerations that bear on scientific discourse.

The central point here, however, is that if every collaborator is able to articulate epistemic reasons for her intra-scientific testimonies, it is far more feasible to "reverse engineer" a collaborative scientific process. This, in turn, renders it far more feasible to locate the culprit in a scientific process that has gone awry. Here the demands of accountability align rather well with the demands of revisability. Given that multiple scientific desiderata yield a requirement of discursive justification on intra-scientific testimony, there are several strands of mutually reinforcing motivation for the present proposal that aspects of the accountability requirement can be distributed in scientific collaboration.

²⁰ Alternatively, the lab assistant may be seen as a mere instrument for her superordinate principal investigator rather than as a genuine collaborator in the scientific process.

Winsberg, Huebner and Kukla suggest that “an agent (or a carefully organized group of agents) that is able to successfully construct a social model of the collaborative structures below her, such that the data she receives can be successfully transformed into canonical data.” (Winsberg, Huebner and Kukla 2014: 22). Moreover, they suggest that this individual or group must be responsible for the model of the scientific process: “The social model is part of the methodology of the research and as such (at least one of) the collaborators must be able to vouch for and defend it” (ibid).

This may seem like a rather strong requirement that some radically distributed scientific collaborations fail to meet.²¹ Moreover, it might be incompatible with emerging scientific practices such as crowdsourced science (Estellés Arolas and González Ladrón-de-Guevara 2012, Huebner, Kukla and Winsberg 2014). Some distributed scientific processes may be epistemically superior when lacking any “vouching” individual or group. This is particularly so in interdisciplinary collaborations in which no single scientist or group can be expected to have the expertise to vouch for every aspect of the process. So, it is not clear that there is a *general* compelling epistemic motivation for a requirement according to which a single individual must be able to vouch for the model. Winsberg, Huebner and Kukla are well aware of this. In fact, they argue against the idea that a “centralized control” is always possible (Huebner, Kukla and Winsberg *forthcoming*). Furthermore, they express some pessimism about locating “authorship *simpliciter*” in radically collaborative science (Huebner, Kukla and Winsberg *forthcoming*, Sect. 6). But it should be noted that the requirement that *at least one* collaborator or a group of collaborators be accountable is compatible with distributing the accountability.²²

The present requirement on the intra-scientific *testifiers* who contribute input to the collaboration provides an additional and fairly specific way of distributing accountability. This requirement is a good deal weaker than the requirement that an individual or group must be accountable for the model of scientific collaboration. For it does not pertain to the model of collaboration but only to the specific testimonies within the collaboration. Locating the epistemic accountability at the level of the individual testifiers provides a way to ensure some measure of accountability even in cases of radically distributed science. I will not go so far as to claim that this is invariably *enough* accountability as well as the right *kind* of accountability given reasonable epistemic and ethical requirements. More general requirements of accountability may be required in many cases.²³ Thus, the suggestion that individual testifiers who provide testimonial input to a collaborative scientific process must be discursively justified is not intended as either necessary or sufficient for meeting a general accountability desideratum. Rather, it is one (perhaps among several) paradigmatic requirements that is standardly generated by the desideratum that scientists be accountable for their processes and output. Despite this limitation, however, it is important to note that it is often the case that an assessment of the chain consists in an assessment of its links.

5. Concluding remarks. Commonplace scientific collaboration based on a division of epistemic labor requires intra-scientific testimony. However, collaboration based on a division of labor may be regarded as part and parcel of the scientific *method*. In consequence, the norms governing intra-scientific testimony are important to a characterization of the scientific method. Given that this is part of the significance of the epistemic norms on intra-scientific testimony, I have provided a specific proposal for an epistemic norm that paradigmatically governs intra-scientific testimony.

²¹ I do not assume that if some existing or emerging scientific practices do not meet a given requirement, then the requirement is *ipso facto* problematic. Sometimes philosophers of science can contribute to scientific practices by suggesting ways to improve them. But, of course, it is important to be sensitive to the aspects of science that contribute to its success even if they do not live up to philosophical ideals of rationality.

²² Thanks here to Bryce Huebner and Eric Winsberg for correspondence.

²³ I suspect that it will be naïve to pursue a perfectly general requirement on scientific collaborations. The nature of the scientific discipline as well as the degree and mode of collaboration will be among the determinants of the nature of accountability that it is reasonable to require. This suggests that a more piecemeal approach is called for.

The proposal consists of, DJA, which is a fairly demanding species of a more general epistemic norm of assertion. This norm sets forth a requirement on the testifier to the effect that she be able to articulate epistemic reasons for her testimony – i.e., that she possess discursive justification. The required strength of the required reasons is determined by aspects of the conversational context. The conversational context, in turn, is determined by matters such as urgency availability of further evidence, social roles, associated stakes and so forth.

The proposed norm is a quite demanding epistemically *internalist* norm. Moreover, its internalist requirements may be especially demanding in interdisciplinary cases. As such, the present focus contrasts with the focus on the structure of science as governed by a sort of “invisible hand” that maximizes scientific output by organizing the efforts of self-interested individuals (Hull 1988, Kitcher 1990, 1993, Strevens 2003). Likewise, the present focus contrasts with the focus on the role of trust and testimonial entitlement that concerns the epistemic status of the *receivers* of intra-scientific testimony (Goldman 1999, Wilholt 2013).

The contrast is one of focus. The present proposal is compatible with such accounts of the structure of science. But it complements them by emphasizing the epistemic norms that individual *providers* of intra-scientific testimony are subject to. Even if individual scientists do not (and need not) appreciate the structure of the entire scientific process of which they are a part, they are nevertheless subject to important epistemic norms. Of course, the epistemic norms governing intra-scientific testimony are mostly tacit norms. But there are important social pressures which enforce them insofar as there can be severe consequences for a scientist who violates them. Someone who is recognized as providing intra-scientific testimony despite being able to articulate any reasons in support of it will be unlikely to succeed in the scientific community in the long term.

To make this suggestion more concrete, I have argued that the present proposal aligns with recognized scientific virtues such as replicability and revisability as well as with a broad desideratum of accountability. Thus, the present proposal of the specific norm governing intra-scientific testimony is not a revisionist proposal. Rather, it reflects the actual practices and concerns in collaborative science. Although these aspects of scientific practice are often tacit, they sometimes surface as illustrated by the Kahneman-led debates in social and cognitive sciences.

The present discussion is a first step in integrating the epistemology of testimony and epistemic norms of assertion with considerations about scientific collaboration and the scientific method. So, as a manner of conclusion, I will indicate some of the novel questions that this integration gives rise to.

Scientific testimony is sometimes argued to have a normative aspect (Douglas 2009, 2014, Elliot 2011, 2013, Hansson 2007, Levi 1960, Rudner 1953). Normative intra-scientific testimony gives rise to hard questions. Does intra-scientific testimony that represents a value judgment give rise to special epistemic requirements? Or is it rather subsumable under the general idea that one must be able to articulate epistemic reasons in support of it? A special case of normative intra-scientific testimony presents itself the human and social sciences that are *intrinsically* normative. Do we need a special epistemic norm for such intra-scientific testimony? Or may we rather develop DJA by enriching the determiners of the conversational context?

I do not at present have answers to these questions. One reason is that the discussion above has not relied much on empirical investigations of intra-scientific testimony. Another reason is simply that the questions are novel and hard. But they also strike me as too important to ignore. It is often maintained that collaboration is part of the scientific process and method. But scientific collaboration involves intra-scientific testimony. Therefore, a characterization of the scientific process and method should include a characterization of intra-scientific testimony. I have begun such a characterization by focusing on the epistemic norms governing intra-scientific testimony.²⁴

²⁴ An early version of the paper was presented at the University of Copenhagen in the fall of 2014. Thanks to the participants and to Thor Grünbaum, Emil Møller and Bjørn Hallson for subsequent discussion. Thanks also to Axel Gelfert, Bryce Huebner, Martin Kusch, Eric Winsberg and the editors of *Philosophy of the Social Sciences* for helpful correspondence.

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