The Puzzle of Scientific Disagreement

Accepted for publication in the European Journal for Philosophy of Science

Mariangela Zoe Cocchiaro
Jagiellonian University
Krakow, Poland
zoe.cocchiaro@yahoo.it

Borut Trpin
MCMP, LMU Munich
Munich, Germany;
University of Maribor
Maribor, Slovenia;
University of Ljubljana
Ljubljana, Slovenia
borut.trpin@lrz.uni-muenchen.de

DECLARATIONS

- Availability of data and material: N/A
- Competing interests: None
- Funding: MZC's work was supported by the grant 2019/34/E/HS1/00044, 'Epistemic inaccuracy and foundational issues in formal epistemology', financed by the National Science Centre (Poland). BT would like to thank the Humboldt Foundation, the German Research Foundation (DFG, projects 448424181 and 455912038), and the Slovenian Research and Innovation Agency (ARIS, project J6-60107) for their kind support of his research. BT also acknowledges the financial support from the Slovenian Research Agency (research core funding No. P6-0144).

- Author contribution: MZC is listed as the lead author for conceiving the presented ideas and writing the majority of the initial draft. BT contributed to shaping the overall argumentation and took the lead in preparing the revisions.

- Acknowledgements: Thanks to the audiences at POND Meeting in Barcelona, 2019, and at the European Epistemology Network in Glasgow, 2022, for their helpful comments on earlier versions of this paper. Thanks also to anonymous peer reviewers whose comments helped us improve the paper.

Abstract

Scientists often find themselves in disagreement with their peers, yet continue to hold fast to their views. While Conciliationism, a prominent position in the epistemology of disagreement, condemns such steadfastness as epistemically irrational, philosophers of science often defend it as rationally permissible—indeed, even beneficial for scientific progress. This tension gives rise to what we call the puzzle of scientific disagreement.

Keywords: scientific disagreement; conciliationism; steadfastness; epistemology; philosophy of science

1 INTRODUCTION

Scientists often find themselves in disagreement with their peers on theories and hypotheses across all fields. Economists publicly disagree on whether poverty is caused by behavioural or economic factors (Bramley, 2016). Ecologists disagree on how to explain the abnormally high mortality recently detected in many honeybee colonies both in Europe and the US (Maxim and van der Sluijs, 2007). In physics, the correct interpretation of quantum mechanics remains a contentious issue (Cretu, 2020). These disagreements usually persist through time: the so-called "cholesterol war" on the causes and effects of hypercholesterolemia in medicine, for example, lasted for decades (Parkkinen et al., 2017). With a slogan, disagreements in science are commonplace (Dellsén and Baghramian, 2021).

These disagreements often find their way into the public arena. Consider, for example, the recent disagreement between Johan Giesecke, Professor Emeritus at the Karolinska Institute of Stockholm as well as the advisor to the Public Health Agency of Sweden, and Neil Ferguson, professor of mathematical biology at the Imperial College, in charge of the Imperial College COVID-19 Response Team and (at the time) member of the British Scientific Advisory Group for Emergencies (SAGE). This disagreement took place in the first months of the COVID-19 pandemic and concerned at least two issues. The first was the infection fatality rate of COVID-19 – roughly, the proportion of deaths among all infected individuals. The second was whether the severity of the intervening measures for reducing COVID-mortality (such as self-isolation, schools' and universities' closures and so

on) would have made a big difference on the number of deaths in the long run. The disagreement persisted over time and unfolded in a variety of public venues, from online magazines to daily newspapers (Sayers, 2020b,a; Science Technology UK Committee, 2020). We will use this case as our running example throughout the paper because the lessons we can draw from it apply to many other scientific disagreements. As one may expect, such publicised scientific disagreements also decrease the attention and acceptance of particular science issues (for empirical evidence, see Chinn and Hart, 2022).

However, our focus will not be on public trust in science. Rather, our central question will be whether the persistent disagreement was epistemically rational (i.e., in line with reasonable epistemic norms). Was it rational for the scientists to hold fast to their views in spite of the disagreement with a colleague – plausibly a peer – or should they have reconsidered their positions in light of it? In other words, may scientists reasonably agree to disagree? Apart from its being interesting by itself, the importance of the question becomes apparent when the disagreement trespasses the academic boundaries, as when, say, the scientists' opinions inform governments' policies.

Two ready-made replies to the question are already available in philosophy. The first comes from the many epistemologists who have investigated the most rational response to peer disagreement for over a decade. By the lights of the most prominent position in the epistemology debate (Frances and Matheson, 2024) – known as "Conciliationism" – scientists like Giesecke and Ferguson cannot steadfastly stick to their guns on pain of epistemic irrationality. The second ready-made reply comes from philosophers of science who often point out the value of sticking to one's position in light of a scientific disagreement (see Biddle and Leuschner, 2015, p. 262, and Dellsén and Baghramian, 2021, for an overview), for several reasons ranging from underdetermination to the risk of premature convergence on a false theory.

This leads to what we call the puzzle of scientific disagreement: on the one hand, epistemologists argue that, under certain conditions that prima facie apply to scientists as well, disagreeing agents should not steadfastly stick to their guns and, instead, ought to conciliate. On the other hand, philosophers of science argue

that not only is steadfastness permissible, but it may also be beneficial for scientific progress. Hence, it is not clear how a scientific disagreement ought to be resolved – from a normative perspective, there is a conflicting pressure on the scientists to change their minds and to not change their minds because of the disagreement.

The central contribution of our paper is to identify this tension between the norms of epistemology and the philosophy of science, to show that it cannot be easily resolved, and to explore how to navigate it. While we focus on scientific disagreements, the same insights also apply to everyday disagreements. Both types of disagreement involve conflicting pressures to conciliate and remain steadfast, but the prevalence of each norm depends on the nature of the disagreement, with the everyday disagreements typically favouring the conciliatory norm.

This is because when a disagreement among peers is short-term and does not require or allow further evidence-gathering (e.g., a simple factual disagreement), conciliation is often more reasonable, as it signals that one of the parties is mistaken and it cannot be determined which one is mistaken. Such cases are common in everyday disagreements, for example, when two friends with similar vision and background knowledge disagree about whether a car they saw from a distance was a Jeep or a Land Rover. However, when a disagreement arises in the context with foreseeable further inquiry (as is often the case in scientific contexts), steadfastness may be more appropriate, as it prevents premature convergence on a false conclusion; for example, when two research teams studying the causes of a rare disease disagree about the underlying mechanism, it may be better for them to each pursue their line of inquiry until more evidence can be gathered to settle the question. This explains why conciliation is more commonly emphasized in general epistemology, while steadfastness is more emphasized in the philosophy of science, where sustained inquiry plays a crucial role. Ultimately, both norms are at play simultaneously, and we will discuss some ways of identifying which norm may be more prevalent in a given disagreement.

Here is the roadmap: in section 2, we introduce the debate on peer disagreement, focusing on Conciliationism as a central position. According to this position, disagreeing peers, including scientists, should conciliate. In sections 3 and 4, we examine whether scientific disagreements could potentially fall outside the scope of

Conciliationism, due to issues related to epistemic peerhood and underdetermination of theories. We conclude that Conciliationism cannot be easily avoided in the context of scientific disagreements. In section 5, we address potential strategies to avoid conciliation, such as epistemic downgrading and appeals to majority opinion, and show that these strategies also fail to exempt scientists from the conciliatory requirements. In section 6, we shift our focus to the justification of steadfastness in scientific disagreements, arguing that, despite the strong case for conciliation, steadfastness is also well-justified, particularly due to the broader benefits for the scientific community. Finally, in section 7, we discuss the persistent puzzle between Conciliationism and Steadfastness and propose a pluralist approach that suggests some factors which may justify the prevalence of one of the two epistemic norms when responding to a scientific disagreement. We conclude in section 8.

A few caveats before we start. In this paper we are not concerned with how it is that scientists come to disagree with each other. They do. Nor with whether the emergence of their disagreement is epistemically rational or not. It might well be. What we are concerned with is "only" whether scientists' response to a scientific disagreement by remaining steadfast or conciliating is the epistemically rational choice.

2 CONCILIATIONISM

What is the most rational way to handle a disagreement[1] with someone whom one considers as being in as good epistemic position as one's own with respect to the debated matter? To conciliate – say the many epistemologists who for over a decade now have investigated the rational response to peer disagreement (see, among others: Christensen, 2007, 2014a; Kelly, 2010).

The doxastic movement that epistemologists require from the disagreeing agents varies: some claim that they are allowed to mildly change their minds (Kelly, 2010); others, that they need to split the difference with the disagreeing peer (Christensen, 2007; Elga, 2007). A few argue that it depends on the circumstances of the disagreement (Lackey, 2010). Because it does not affect our argument, we will not

[1] For an account of what we mean by disagreement, see Omitted1.

consider in details any of these different ways to conciliate.[2] We will instead focus on Conciliationism in a general way as a family of views that requires the agents to change their minds rather than steadfastly sticking to it in the presence of a disagreement with a peer.

2.1 The Conciliatory Set-Up

The truth of Conciliationism as a general theory about the epistemically rational response to disagreement is often derived by generalizing from intuitive cases. An example is the Restaurant case in which upon looking at the bill an agent thinks that her shares of the bill are 43 dollars each while her equally reliable friend thinks they are 45 (Christensen, 2007). In jargon, the agents are "epistemic peers":

> Acknowledged peerhood: they are equal in reasoning ability, intelligence, intellectual virtues, and in the evidence, background information, and concepts they possess (Matheson, 2009, p. 270).
>
> This symmetrical distribution of epistemic features ensures that the agents are equally likely to respond rationally to the evidence (Christensen, 2014a) and/or equally likely to form accurate beliefs in response to the evidence (King, 2012, Frances and Matheson, 2024; Elga, 2007; Christensen, 2014a, p. 593).
>
> Importantly, the peers also recognize each other as such.

As suggested in the Restaurant case, in the disagreement narrative at some time t_1 the agents who are – and recognize each other as – peers in the way just described disagree about Q unbeknownst to each other. Let this disagreement consist of them assigning different degrees of belief to Q (Fleisher, 2021). At t_2 the peers tell each other what they think about Q and, thereby, they obtain knowledge of their disagreement.

The primary normative question in the standard debate on disagreement is how the admission of the peer disagreement should affect what the agents think of

[2] Our main argument still stands even if one endorses views that require only one agent to change her mind, such as the Right Reasons view (Frances and Matheson, 2024).

Q at a following time t_3: are they reasonable if they stick to their initial opinion on the shares of the bill at the restaurant, upon learning of their friend's belief?

2.2 The Conciliatory Rationale

A "natural", "appealing" (Elga, 2010), under some circumstances even "obvious" (Kelly, 2010) answer to the question is that the Restaurant agents are not reasonable if they stick to their initial opinion. Instead, they should become less confident that their shares are 43 and 45 respectively. The disagreement is in fact evidence that at least one of them is wrong. More precisely, it is evidence of the failure of either agent's abilities in assessing the normative import of the evidence, that is the share actually supported by the bill (Whiting, 2021, Fleisher, 2021).

For all they know they cannot rule out that it is them who miscalculated the shares rather than their peer (Fleisher, 2021): after all, the agents are fallible, and aware of it. According to some, it might be hubristic/arrogant (Lee, 2007) to drop the possibility that they are the ones who got mistaken in any case of disagreement, no matter the epistemic standing of the other party (Frances, 2010). But it would certainly be so to rule it out when everything that is cognitively accessible to them and the agent with whom they disagree is wholly symmetrical, as is the case when the disagreement occurs with a peer. The disclosure of the disagreement in the Restaurant case then gives each agent a reason to believe that they are mistaken. In jargon:

(Higher order) defeat: Learning that a peer disagrees with her on Q gives the agent a reason to believe that the doxastic attitude she has adopted toward Q is mistaken (Frances and Matheson, 2024).

The mistake in question is often taken to be a mistake in responding to the evidence, to the effect that by learning of the disagreement the agent gets a reason for thinking that her doxastic attitude toward Q is irrational, that is that the shared evidence did not justify it in the first place (Fleisher, 2021, Whiting, 2021; Matheson, 2015, p. 66), hence the need to revise her belief that is mandated by Conciliationism (see, among others: Matheson, 2009):

Conciliationism: If an agent has a certain credence c_1 with respect to Q and then learns that someone whom she acknowledges as an epistemic peer has a different credence c_2 towards Q, then (ceteris paribus) the agent is not allowed to stay exactly as confident as she initially was regarding whether Q. More precisely, she should adopt a new credence c_3 which is significantly closer to c_2 (than c_1 is) (Fleisher, 2021).[3]

3 EPISTEMIC PEERHOOD IN SCIENCE?

The puzzle at the core of this paper stems from the application of the conciliatory lesson from epistemology to disagreements arising in a scientific setting, such as the one between Giesecke and Ferguson that we mentioned in the Introduction. According to the former, two scientists who are epistemic peers and who find out that they disagree with each other cannot steadfastly stick to their guns on pain of epistemic irrationality while according to philosophers of science, they can. Now, one might argue that the friction between epistemology and philosophy of science does not even arise and that there is no puzzle at all: scientific disagreements do not fall within the scope of the epistemology debate, because the latter is concerned with agents who are epistemic peers and scientists cannot be peers. Our reply to this objection – that we investigate in this section – is that scientists can indeed be peers, at least on the best accounts of the notion of epistemic peerhood available on the market, as we argue in what follows.

3.1 Ideal Peerhood: Successes and Failures

On the account of peerhood introduced in Section 2.1 –call it the "ideal" account–, epistemic peers share any epistemic factor that is deemed as relevant for the issue at stake. But this makes them look more like epistemic clones than real agents (Lackey, 2010; King, 2012) and clones or nearly-clones are impossible to find in real life. The insights from epistemology might then concern the behaviour of ideal agents. Yet, there is no reason – apart from a miracle – for extending its lesson to ordinary ones. While this account succeeds in neutralizing the complaint that

[3] For a formulation of Conciliationism in terms of epistemic justification, see Matheson (2009).

actual scientists are irrational by denying that they typically have any peers, it carries with it some undesirable consequences.

The first is that, under the assumption of ideal peerhood, the philosophical discussion on disagreement loses its normative force and fails to fulfil one of its goals: to provide guidelines for informing everyday epistemic reactions to peer disagreement (Matheson, 2015; Christensen, 2014b; Lackey, 2010).[4] The second counter-intuitive consequence is that, if epistemic peers need to share evidence, background and so on, ordinary agents are never actual peers. If this is the case, then all ascriptions of peerhood from daily life are empty: the friends, the colleagues, the siblings and all the other people whom ordinary agents recognize as peers are actually not our peers, but always either our epistemic superiors or inferiors.[5] There is no in-between and peerhood is just a fiction.

On the one hand, the emptiness of peerhood ascriptions is confirmed in scientific practice where the notion of peerhood is typically applied rather loosely, referring to scientists working on similar topics, rather than adhering to the stricter equivalence criteria epistemology would demand. We know that the appeal to peerhood in practices like peer reviews and open peer commentaries is often empty (Cruz and Smedt, 2013, p. 170). For instance, we might label someone as a "peer reviewer" even when they are a highly successful professor with a long track record of influential publications on the topic under review, while the author of the paper is a graduate student. The student and their (alleged peer)-reviewer professor are clearly not peers in the sense of the ideal account.

On the other hand, however, scientific practice offers at least two reasons to believe that peerhood ascriptions cannot always be empty. Firstly, scientific practice provides the tools to identify peerhood, as the quantitative and publicly available machinery consisting of, among others, indexes and rankings and aiming at

[4] According to Christensen (2014b), epistemologists hope that "by understanding the rational response to disagreement in simple cases, they will get some insight into what the rational response is in the more complex ones involving the public controversies among groups that give the issue much of its urgency" (p. 143).

[5] There are multiple ways of defining epistemic superiority (inferiority), e.g. with respect to the greater (lower) probability of being right (false) in a disagreement or with respect to the agent's epistemic position in relation to the contested proposition (see Frances and Matheson, 2024, 4).

assessing scientists' performances offers a heuristics for identifying instances of potentially genuine peerhood in science. Think of two agents whose PhD training was in the same field and who are both research-active in it. Suppose that: (i) they are at the same point in their career as shown by their titles (they are both, say, associate professors) and academic qualifications; (ii) they have the same number of scientific publications in journals which rank more or less as high, a similar, say, H-index as well as an equally good record in winning major grants; (iii) they also work in equally prestigious universities, have access to good labs and so on. Intuitively, agents so-described are at least good candidates for epistemic peerhood (Cruz and Smedt, 2013).

Secondly, peerhood seems also to be an operational assumption in the public arena. An official pre-requisite for being appointed to the committees of many grants in Europe is to "possess at least the same level of qualifications (in relation to their academic age) as the applicants", as detailed by, for example, the Austrian Science Fund – thereby hinting at the notion of epistemic peerhood.[6] There are also clues that sometimes the members of these committees act as if they were peers.

Take, for example, "Horizon Europe", the EU's key funding program for research and innovation and, in particular, the evaluation of proposals as per the corresponding version of the grants manual (European Commission, 2015). The evaluation process for Horizon Europe usually consists of three phases: (i) individual evaluation; (ii) consensus group; (iii) panel review. What matters for our purposes is step (ii) in which the experts have to reach an agreement on how to aggregate their individual scores so as to issue a group score. The discussion to which all the experts on the panel take part for these purposes is led by the so-called rapporteur, a member who is also in charge of issuing an internal report in which the rationale of the decision which led to the group score is laid out.

According to the above-mentioned grants manual (European Commission, 2015), if the majority of experts agrees, the group score can be –and indeed often is (European Commission, 2020)– obtained by linear averaging of each member's individual

[6] At least insofar as the relevant qualifications, such as degrees, titles, publications and so on, are suggestive of the agent's epistemic standings.

score. But this means that in the cases in which the experts agree on linearly averaging their individual scores, all non-epistemic factors (such as time constraints and so on) being equal, they act as if they acknowledged their epistemic standings to be on a par. That is, they act as if they acknowledged each other as peers. The ascription of peerhood in these cases is not empty and an adequate account of the notion should – at least in principle – be able to accommodate them. The ideal account of peerhood needs to be discarded.

3.2 A More Fitting Account: Ordinary Peerhood

A more adequate account is already available in the literature: according to it, two agents are peers if they have approximately the same cognitive abilities and approximately the same evidence.[7] Unlike the ideal one, such approximate account of peerhood does not undermine the normative force of the discussion on disagreement, and it accommodates many daily life ascriptions and uses of peerhood. On this account of peerhood, scientists can be epistemic peers.

Yet, by requiring the relevant features to be more or less the same, this option rules out cases of epistemically different scientists who are nevertheless epistemic peers (Cocchiaro and Frances, 2021). An example: two of the worldwide leading institutes in the field of primatology – the Max Planck Institute for Evolutionary Anthropology and the Kyoto Primate Research Institute – greatly differ in how they set up the experiments, gather the evidence, interpret it and so on (Cruz and Smedt, 2013). Nothing prevents – at least in principle – scholars working in the two institutes from being peers with respect to, say, great ape gestural communication. The approximate account of peerhood rules out cases of epistemically different peerhood of the primatologists' kind a priori. Again, we can find an even more adequate account accommodating this need in the literature:

> Ordinary peerhood: Two agents are peers with respect to the proposition Q if they are in equally good epistemic positions to judge Q (Matheson, 2015; Frances and Matheson, 2024).

Following the epistemologists' lead, in a scientific setting two agents' epistemic

[7] See, for example: Christensen (2007, p. 188).

positions are equally good if they both have a similar rate of successes and failures in a particular domain of enquiry. Once again, on this account scientists can be epistemic peers.

3.3 The Conciliatory Set-Up in Science

Upon replacing the ideal account of peerhood with any of the already available more adequate alternatives, scientific disagreements like the one between Ferguson and Giesecke mentioned above qualify as disagreements between peers – who by means of public interactions in scientific venues recognize each other as such. Given that many of the credentials contributing to their epistemic position, such as publications, training and so on, were publicly available, it seems in fact plausible to assume that both Ferguson and Giesecke considered each other as peers at least prior to the disclosure of the disagreement.

Their disagreement also shares the same temporal structure as the ones in epistemology: we can picture Ferguson and Giesecke as reaching at t_1 two different conclusions on the fatality ratio of COVID-19, given more or less the same batch of evidence – mainly, data from China and Italy in the beginning (Science Technology UK Committee, 2020). The philosophical question of what is the best way for them to respond to their disagreement arises after its disclosure at t_2 and its conciliatory solution at t_3 leaves the scientists vulnerable to the charge of epistemic irrationality. The first move to dissolve the puzzle of scientific disagreement—by challenging the idea that such a puzzle even arises on the grounds that scientific disagreements do not fall within the scope of the epistemology debate and of Conciliationism in the first place—has failed.[8]

[8] For the unconvinced ones who still think that peerhood does not exist, it is worth noticing that prominent scholars in the disagreement literature (Frances, 2010) claim that disagreement with epistemic superiors should demand lowered confidence as well. So denying that there are peers does not help: in each case of disagreement between non-peers, presumably at least one party will need to defer to a superior and if she does not, she will become vulnerable to the charge of epistemic irrationality.

In Restaurant-like cases the disagreement arises because one of the agents does not assess the evidence in the correct way and thereby provides the peer with a reason to believe that the evidence does not justify their attitude toward the issue at stake. In other words: the disagreement works as a higher-order defeater (Fleisher, 2021, Whiting, 2021; Matheson, 2015). The second move for blocking the puzzle of scientific disagreement at the outset is to claim that in scientific disagreements like the one between Ferguson and Giesecke the disagreement does not fulfil the same function. In this case the conciliatory pressure might fade away and it could be epistemically permissible for disagreeing scientists to stick to their guns. In this section we explore this possibility.

4.1 Underdetermination, Permissivism and Conciliationism

In science sometimes the evidence available at a given time is insufficient to determine what beliefs scientists should hold in response to it, that is, it does not single out a unique scientific judgement (Jackson and LaFore, 2024; Matheson, 2015). This is highly reminiscent of the position from epistemology known as permissivism, which holds that given the same body of evidence, it is possible for there to be more than one rational response or credence. Indeed, the formulation of underdetermination in philosophy of science is taken to "correspond to the permissivist claim, that, in some cases, the currently available evidence leaves open more than one rational response to a proposition" (Jackson and LaFore, 2024, p. 364).[9]

But a permissivist account of rationality undermines the higher-order defeat condition and, according to some, the conciliatory position that rests on it (Kelly, 2010). Only if there is a unique rational reaction to the evidence – the rough argument goes – learning that a peer disagrees with me gives me a reason to

[9] It could also be that in the presence of underdetermined scientific claims there is no rational attitude to take with respect to the issue at stake. We plan to explore this possibility in future investigations and for now we adopt instead Jackson and LaFore's (2024, p. 364) take on the matter.

believe that my attitude is irrational. If not, both attitudes might well be rational (Matheson, 2015).

In sum: (i) if there are cases of scientific disagreement in which the theory is underdetermined by the evidence, and (ii) if Conciliationism fails in a permissivist scenario as some claim, then (iii) there are cases of scientific disagreement in which the pressure to conciliate does not arise. In these cases scientists can be steadfast and the puzzle does not arise. The disagreement between Ferguson and Giesecke might, for example, be one of them.[10] Let's start by focusing on (i).

4.2 Underdetermination and Disagreement

Are scientific claims at least sometimes underdetermined by the available evidence in case of disagreement? Yes, according to the sociologists who in the 1970s reviewed a pool of scientific controversies as case studies and concluded that during scientific disagreements the experiments' results exhibited the feature of "interpretative flexibility" (Collins, 1981; Pinch, 2015). In other words: the data were suitable for different and equally convincing interpretations, i.e. they were underdetermined (Collins, 1981).

One of the case studies was, for example, a controversy in experimental physics on the existence of a physical entity known as magnetic monopole. While a magnet bar usually has two poles, "north" and "south" and is therefore a dipole, a monopole has only an isolated north or south pole (Pickering, 1981). In 1975 a group of scientists led by P. B. Price claimed that the monopole existed while Alvarez and other Berkeley colleagues rejected the claim.

Sociologists of scientific knowledge argued that the source of this controversy was that the data assessed by the scientists fitted equally well both the monopole theory and a theory alternative to it. More generally, they concluded that scientific disagreements always occur when the claim at stake is underdetermined by the evidence (Pinch, 2015). In this paper we use their empirical work as support for the weaker conclusion that there are cases of scientific disagreement in which the claim is underdetermined and rationality is permissive (Jackson and LaFore, 2024).

[10] See Antiochou and Psillos (2022) for an argument that a similar COVID-19-related disagreement between Ioannidis and Taleb was of this type.

However, the underdetermination of a scientific claim by the evidence in cases of peer disagreement does not necessarily prevent the latter from working as a higher order defeater. Conciliationism in fact still thrives even in permissivist scenarios of rationality insofar as the permissivism is moderate rather than extreme (Matheson, 2015, Ch. 3). Extreme permissivism is the claim that a body of evidence does not put any rational constraint on the agent's doxastic attitude. Otherwise said: given a batch of evidence, anything goes. Moderate permissivism which seems more appropriate for scientific research, on the other hand, is the claim that the evidence does put some rational constraint on the agent by supporting a restricted range of rational opinions (Matheson, 2015, Ch. 3).

Hence, an agent could still think that she misjudged the evidence: after all, it might well be that her doxastic attitude does not fall within the range of permitted credences (Matheson, 2015; Christensen, 2014a). It is, therefore, possible to preserve the role of the disagreement as a higher-order defeater if one assumes that in the case of peer disagreement one of the scientists' attitudes necessarily falls outside the range of the permitted ones. In this case, the higher order defeat condition holds even in the presence of claims which are underdetermined by the evidence.

But on which grounds should one grant that in the presence of a scientific peer disagreement and of moderately permissive evidence one of the scientists is necessarily irrational, as we just did? Quite the opposite, when two scientists like Ferguson and Giesecke assign different degrees of belief to the proposition at stake given more or less the same evidence, it seems plausible to think that both doxastic attitudes fall within the rationally permitted range.

4.3 Defeat and Conciliationism

Even if their attitudes are both rational, the scientists are still under the pressure to revise their own opinions in the presence of a peer disagreement. Conciliationism in fact holds true even in permissivist scenarios of rationality with the only difference that in the latter case its defence is solely driven by accuracy concerns (i.e., how close to truth the agent is; see Christensen, 2014a) rather than by rationality ones

(i.e., what is the most reasonable response due to some norm).[11] As Christensen notices (2014a), considerations of accuracy and considerations of rationality are the two strands at the core of Conciliationism. Usually they go hand in hand, to the effect that being concerned about one's own rational response to the evidence often also means to be concerned about the accuracy of one's own attitude. But they can also be separated and, in the absence of concerns about our rationality, concerns about accuracy still stand.

A peer's credence can then force an agent to revise her credence not only by constituting evidence that the latter is irrational, as we have seen so far, but also by constituting evidence that it is inaccurate (Cohen, 2013) – which is the core idea of conciliatory defences in permissivist scenarios of rationality. More precisely: even when the (disclosure of the) peer disagreement does not point to a failure in processing the evidence, it nevertheless is still evidence that one of the agents is less accurate (Christensen, 2014a; Elga, 2007)[12] – and this puts the agent under rational pressure to revise their credences.

To use Christensen's (2014a) illustrative example: in a subjective Bayesian framework in which an agent is rational insofar as they are probabilistically coherent and update by Bayesian conditionalization, there might well be agents whose prior probability functions are non-wacky. That is, these priors might be such that if the agent "encounters evidence that strongly suggests that his beliefs are inaccurate, he'll change his beliefs accordingly" (ibid., p. 589). Now, the peer disagreement is an example of such evidence and, out of all agents, one would think – even expect – that scientists have the above-mentioned non-wacky priors. As a result, in response to the disclosure of a peer disagreement, scientists like Giesecke and Ferguson should conciliate even if the claim at stake is underdetermined by the evidence and there is more than one rational response to it. The puzzle still stands, after all.

[11] This line of argument is endorsed by Christensen (2014a) and Cohen (2013), and lurks in the background of some defences of Conciliationism, such as those by Elga (2007) and Frances (2010).

[12] In jargon: the disagreement is a rebutting defeater rather than a (higher order) undermining one. The differences do not concern us here.

5 IS IT ALL LOST?

Scientific disagreements like the one between Ferguson and Giesecke fall within the scope of the peer debate as well as of Conciliationism. Shall we conclude that the pressure to conciliate in light of a scientific disagreement is unavoidable? Not yet, as there are still at least two other cards to play using the suggestions that have been made in the epistemology literature. We will consider them in this section.

5.1 Epistemic Downgrading of the Peer

The third move for blocking the pressure of Conciliationism amounts to using the disagreement itself as a reason for demoting the agent with whom one disagrees from peerhood. This makes room for the epistemic permissibility of steadfastness: upon downgrading the peer to an epistemic inferior, the disagreement no longer works as a defeater and the conciliatory argument does not go through. It is in fact at least unclear whether learning of a disagreement with an epistemic inferior gives the agent a reason to believe that she is mistaken.

But such epistemic downgrading of a peer on the basis of the disagreement is problematic for two reasons. Firstly, allowing it would clear the path for reasonings which are paradigmatically and awfully dogmatic "in the pejorative sense of that term" (Kelly, 2013, p. 14). An example is a scientist thinking: "My colleague disagrees with me and in general our approaches to the matter, the way we set up experiments, gather the evidence, interpret it, and so on are equally successful. But in this case I am right and she is wrong so I can stick to my guns." The conclusion is clearly unjustified and fully arbitrary. Hence, while it could explain what sometimes happens in practice, it does not have the normative sway. Secondly, this downgrading, if used as a general tactic, seems to allow an agent – say a Bachelors' student in mathematics – to dismiss even the disagreement with those she took to be her superiors in the field – say, her two Fields medal-winning professors (Christensen, 2011; Cohen, 2013). Conclusion: downgrading a disagreeing peer on the basis of the disagreement itself is not a great move in most contexts, including science.

5.2 Numbers Matter

In the epistemology literature it is widely supposed that the numbers of advocates for alternative positions are epistemically relevant (for a classical reference, see, e.g., Lewis, 1946).[13] In the case of the disagreement between Ferguson and Giesecke, for example, either might be excused from conciliation on the grounds that their conclusions are in closer alignment with the majority of experts. In effect, in an interview for the online magazine UnHerd, Ferguson claimed that the majority of epidemiologists agreed with his position (concerning COVID-19's Infection Fatality Rate (IFR) and the efficacy of lockdowns; Sayers, 2020a). If this were indeed the case, Ferguson's reasons for thinking that it was Giesecke who got mistaken would have outweighed the reasons for thinking that it was him who got mistaken, thereby neutralizing the defeating role of the peer disagreement and the charge of irrationality.

There are at least two problems with this line of response, however. The first concerns the claim as to the existence of the alleged majority. The task of quantifying how many experts agree on a scientific matter is already not trivial for topics which have been debated for a long time. In these cases, in the absence of hard data, a good way to judge the state of play in the community is by checking published literature and conference activity (Vickers, 2022). But Ferguson's claim that the majority of epidemiologists agreed with him dates to the 25th of April 2020, a time in which many of the scientists' manuscripts concerning the fatality rate of COVID-19 and the efficacy of lockdowns had not undergone peer-review yet and were only available as pre-prints. Plausibly, pre-prints are a less reliable indicator of the state of play in the community than scientific publications which underwent peer-review. As a result, it looks like the reference set whose majority Ferguson referred to in his interview consisted of the epidemiologists whom he was aware of or to whom he had access rather than the scientific community of epidemiologists as a whole. This weakens his reasons for thinking that it was Giesecke who got mistaken rather than himself.

The second problem is that in the epistemology literature the importance of the

[13] According to Lewis' view, multiple independent witnesses giving the same report indicates that they are telling the truth.

independence of the relevant opinions of which the agreement consists is often highlighted, to the effect that "the agreement of individuals who came to their opinions on a matter independently count for more, epistemically speaking, than agreement of individuals with a greater shared background" (Frances and Matheson, 2024). If the above-mentioned reference set to whom Ferguson referred consisted of the epidemiologists whom he knew or had access to, it is possible that these scientists shared his background and did not reach their opinions in an independent way.[14] This further weakens the epistemic reasons for discounting himself as the one who made the mistake provided by the majority's agreement.[15]

Overall, we think we have enough reasons for claiming that scientists like Ferguson are not excused from conciliation and that they are not allowed to steadfastly stick to their guns. This leaves them vulnerable to the charge of irrationality if they steadfastly stick to their guns in the presence of a peer disagreement. But even if we were wrong and if scientists like Ferguson were indeed excused, the puzzle of scientific disagreement would still arise with respect to the counter-part with whom they disagree, i.e. Giesecke in our example.

6 THE IMPORTANCE OF BEING STEADFAST

Since our attempt to dissolve the puzzle of scientific disagreement by arguing that Conciliationism is inapplicable to scientific contexts has failed, we now turn to a different strategy: examining whether Steadfastness is an unreasonable position, despite the support it has gained from many philosophers of science. In short: this suggestion will not work – just like there is a strong pressure on scientists to conciliate in light of a disagreement, there is also a strong pressure on them to remain steadfast.

[14] Parametrisation of (in)dependence of sources is a very complicated task, see, e.g., Claveau (2013) and Landes (2021) for two different approaches. Due to space constraints, we here assume a more informal approach according to which scientists are independent if they are in a position to reach different conclusions (e.g., their background assumptions and methodology do not more or less imply the same outcome).

[15] See Solomon (2015, pp. 84-104) for a related critical discussion of consensus practices in science, where the appeal is made to the overall consensus in a field and not just to a sheer majority view.

The arguments in favour of steadfastness in science often shift the focus from individual rationality to the epistemic benefits of disagreement at the group level. History provides numerous examples where seemingly irrational individual behaviour proved beneficial for the advancement of science. Consider Priestley's steadfast commitment to phlogiston theory despite strong evidence against it, or the many naturalists who resisted Darwin's theory until their deaths (Santana, 2021). In the long run, such behaviours, though seemingly irrational, often contributed to scientific progress, suggesting that a failure to conciliate can sometimes be crucial for achieving group rationality—whether in terms of arriving at scientific truths or attaining other instrumental goals of science. Besides its role in, e.g., revealing additional evidence, the pursuit of theories that may very well be false or inaccurate (as suggested by the disagreement) may also help in improving the understanding of the target phenomena.[16] And indeed, increased understanding may even be what scientific progress is all about (see Dellsén, 2016). If the steadfastness of scientists like Giesecke and Ferguson is of this beneficial kind, then there may very well also be a genuine pressure on them to remain steadfast.

6.1 The Epistemic Benefits of Steadfastness

By means of historical evidence, of mathematically rigorous results (Mayo-Wilson et al., 2011) and computer modelling (Zollman, 2010), philosophers and social scientists have shown that individual and group rationality do not necessarily go together. Even more, sometimes they conflict with each other to the point that departures from individual rationality turn out to be instrumental for enhancing the efficiency of the group (Santana, 2021). As an example of such departures: scientists who are credit rather than truth-seekers facilitate a more diverse division of labour across research programs and thereby inadvertently enhance the community's chances of discovering the truth (Strevens, 2003). Along the same lines, the resistance of some scientists to strong evidence against their favoured theory

[16] Although the models are not in a peer disagreement, it is worth noting a similar situation in climate modelling which regularly proceeds by engaging with knowingly mutually inconsistent models (e.g., in the so-called hierarchies of models). This is because such a practice affords better structuring and organisation of the knowledge regarding the target phenomenon (see Omitted2).

helps preserve disagreements over a longer period of time and thereby prevents the community from jumping to a mistaken consensus (Zollman, 2010).

A key feature of these examples is that the behaviours, which may be labelled as individually irrational, contribute to a cognitively diverse community, that is to having researchers who pursue different views, theories and methods. In turn, cognitively diverse communities fare better than uniform ones in achieving their epistemic goals (Kitcher, 1995, p. 344). Departures from individual rationality can therefore be credited with indirectly benefiting the whole community by promoting the epistemically desirable feature (Solomon, 2001) of epistemic diversity. Because it helps establish and maintain the epistemic diversity of the community, the scientists' steadfastness in the peer disagreement case – of the sort displayed by Giesecke and Ferguson in our running example – might well be just another example of such a beneficial departure from individual rationality.

6.2 An Affirmative Defence

If their steadfastness in the peer disagreement case enhances the effectiveness of the scientific community, then we admit to there being a real friction/tension between the pressures of Conciliationism and the benefits of Steadfastness as investigated in philosophy of science. Steadfast scientists might well be epistemically faulty on the individual level, but excusably so with respect to the social level.

If the epistemic good stemming from this steadfastness outweighs its epistemic bad, we might even claim that individual irrationality is a bullet worth biting in the name of the greater good. This could be the case for the disagreement between Ferguson and Giesecke whose steadfastness might be credited with pushing different lines of research on COVID-19 as well as facilitating the testing of two different public health strategies in practice – insights that are potentially very useful in dealing with future pandemics.

The puzzle of scientific disagreement is then not dissolved, but we at least understand where it stems from. The two inconsistent ways of responding to a scientific disagreement emerge because they guide the behaviour from different levels, individual and social. In turn, the attitude of scientists who do not change their minds in the presence of a disagreement with a peer can be explained by them,

so-to-speak, prioritising the greater good stemming from their steadfastness in the long run over their individual rationality. This may be more common in scientific than everyday disagreements for the simple reason that scientific disagreements are part of a process where further evidence-gathering may be expected and Steadfastness may therefore lead to potentially more beneficial investigation of multiple aspects of the contested issue.

Now, thinking that the scientists' steadfastness can be at least explained by them giving priority to the greater good on the social level over their individual rationality comes with two limitations. The first limitation is that it allows disregarding the opinion of an epistemic peer as long as the disagreeing scientists pursue diverse approaches to the contested issue. Even if the disagreement may be good on a group level, the scientists should genuinely engage with their peers and take the disagreement as higher-order evidence or as a signal of inaccuracy of (at least) one of the involved, as established in the previous sections.[17] The second issue is that such an approach may suggest that insisting on what later turns out as a false theory is unproblematic as long as it benefits scientific progress. Plausibly, however, scientists need to also be mindful of the potential consequences of persisting in their positions, especially when their findings influence policy decisions (Biddle and Leuschner, 2015, p. 273). One could argue that such considerations are not strictly epistemic, but rather ethical in nature. Yet, when scientific disagreements have significant real-world consequences -— as in the case of public health or safety —- the ethical implications of maintaining a position and the question of epistemic rationality may potentially even be inseparable. In the case of the disagreement between Ferguson and Giesecke, for example, "several studies have shown that the human costs would have been significantly lower in Sweden if stricter measures had been implemented" (Brusselaers et al., 2022). The stakes of such risks are even heightened in the cases of scientific disagreements in which at least one party is mistaken. The tension between the two conflicting epistemic norms – to conciliate and to remain steadfast – therefore remains.

[17] Of course, uncertainty and doubt may be abused (see Oreskes and Conway, 2011), but we operate under the assumption of a disagreement among peers.

7 NAVIGATING THE TENSION BETWEEN CONCILIATION AND STEADFASTNESS

Having established that the tension between Conciliationism and Steadfastness in scientific disagreement is unavoidable, the next step is to consider how to navigate this tension in practice. The aim is not to suggest a one-size-fits-all solution, as we have already established that two conflicting norms are at play. Instead, we aim to provide insights into when and why one norm may exert more pressure than the other in a given scientific disagreement. And while we cannot provide a universal formula, we believe that we can outline some factors that may help us navigate the tension between two conflicting norms, to conciliate and to remain steadfast. Some of the factors that influence this determination include:

Further Evidence-Gathering: A primary consideration is whether further evidence-gathering is expected. In cases where new evidence or data is likely to emerge, Steadfastness may be more appropriate to avoid premature convergence on a potentially incorrect conclusion and to avoid giving up on fruitful hypotheses. Scientific inquiry often unfolds over time, and maintaining a steadfast position can allow for more rigorous exploration and refinement of hypotheses. On the other hand, in disagreements involving settled empirical facts where little new evidence is forthcoming, conciliation may be a more reasonable option, as the evidence is already strong and further inquiry is unlikely to change the outcome. It is therefore reasonable to be cautious in these cases.[18]

Group-Level Considerations: The social dimension of scientific work is another important factor. While individual rationality emphasizes the epistemic correctness of one's position, group rationality focuses on the epistemic benefits of a diverse range of perspectives. In this context, Steadfastness can be understood as a way to preserve cognitive diversity within the scientific community, ensuring that different hypotheses are tested and explored. This

[18] It seems that norms of inquiry also play an important role in determining the rational response to a scientific disagreement (we address this elsewhere; see Omitted3).

can be especially valuable in complex, multi-faceted scientific problems where competing theories may contribute to a more comprehensive understanding of the issue.

The Context of the Disagreement: The broader context in which the disagreement occurs is also crucial. In the case of fast science (e.g., in early stages of a pandemic or urgent public health decision-making; see also Stegenga, forthcoming), the normative pressures may diverge from those of conventional, slower scientific inquiry. Fast science often prioritizes speed and responsiveness, which may justify a more pragmatic approach to disagreements. For example, in a situation like the early COVID-19 crisis, scientists may feel pressured to make decisions rapidly, even if the disagreement with peers has not yet been fully resolved. In such contexts, the cost of inaction or the wrong action can be extremely high, making Steadfastness and Conciliationism both potentially reasonable, depending on how much evidence is available and the urgency of the decisions at hand.

Non-Epistemic Values and Priorities: As we've seen in the case of Ferguson and Giesecke, scientists' personal, institutional, and ethical values also influence their decisions to remain steadfast or conciliate. For example, a scientist might hold fast to a precautionary principle, prioritizing caution over the possibility of being wrong. Alternatively, a scientist might resist conciliation based on a value commitment to individual freedoms or a belief in minimal government intervention. These non-epistemic factors can complicate the purely epistemic question of which response is rational, but they are nonetheless important in understanding how scientific disagreements unfold. Before proceeding, it is important to stress that the influence of non-epistemic values on scientists' decisions, as highlighted in the case of Ferguson and Giesecke, is primarily a descriptive point. That such values, such as precautionary principles, commitments to individual liberty, or other considerations, shape the behaviour of scientists does not in itself establish that steadfastness is epistemically rational. It may merely reflect what is practically rational, given the agents' broader goals, including policy rele-

vance, institutional constraints, or public trust. Only when these values directly influence the interpretation of evidence or the standards of reasoning, as suggested by Longino's (1990) influential account of value-laden science, can they also affect epistemic rationality. Whether this is the case in the examples discussed here remains open. Our main aim is to highlight the descriptive role of non-epistemic values in shaping disagreement dynamics, while leaving open whether, and when, they play an epistemic role. The challenge is, then, to be transparent about these values and to recognize how they interact with the epistemic norms of Conciliationism and Steadfastness.

While there is no simple resolution to the puzzle of scientific disagreement, understanding the factors at play can help us make more informed judgments about when Conciliationism or Steadfastness is the more justified response – or at least, whether following one or the other norm is permissible. In case of Giesecke and Ferguson's disagreement, for example, it seems that they may very well have acted epistemically rationally when they remained steadfast.

In the end, the key takeaway is that the tension between the two norms cannot be eliminated, but it can be better understood. By considering the nature of the disagreement, the role of evidence, the group dynamics, and the non-epistemic factors, we can begin to navigate the question of rationally responding in a scientific disagreements in a way that respects both epistemic norms and practical concerns. This is not an easy task, and it may require a delicate balancing act, but it is one that may provide a better understanding of what is reasonable both for scientists and the communities they serve.

8 CONCLUSION

In this paper we attempted to solve the puzzle of scientific disagreement, according to which disagreeing scientists are at the same time under two conflicting normative pressures: to conciliate and to remain steadfast. While we did not solve the puzzle (that might well be inescapable), we suggested that there may at least be some ways of determining which of the two norms that are both at play simultaneously may be more prevalent in a given scientific disagreement. It is not the case that

anything goes: e.g., degrading a peer scientist to an epistemic inferior because of a disagreement is not permissible. Similarly, if the disagreement is with respect to a simple factual matter, then the pressure to conciliate will generally prevail. This is the case, for instance, when two researchers using the same methodology and the same evidence come to two different conclusions. However, if the scientists realise that their disagreement essentially boils down to non-factual considerations or when there are clear benefits if they uphold their positions until more evidence is uncovered, then Steadfastness norm may very well exert more epistemic pressure on them.

For instance, beyond the case of Giesecke and Ferguson, consider the ongoing debates over climate change models. Some researchers, such as Lindzen and Choi (2011), advocate for models that predict less severe climate sensitivity (i.e., how much Earth surface warms for doubling atmospheric carbon dioxide) based on observational data. In contrast, more recent studies, like those by Sherwood et al. (2020), support models predicting greater climate sensitivity based on multiple lines of evidence: the disagreement therefore has to do with methodological issues and conciliating would therefore reduce the potential benefits of this methodological diversity. Similarly, in the mRNA vaccine debate, some researchers, like Polack et al. (2020), highlight the promising short-term safety and efficacy of these vaccines, while others, such as Ioannidis (2021), consider their decreased efficacy due to the greater exposure of the vaccinated: the disagreement therefore considers different aspects of the vaccination – how vaccination affects individuals (increased safety) and how these individuals afterwards behave (increased risk which may cancel out the increased safety from the vaccination). Here, a more conciliatory response is more justified as it may help the scientists understand that they are addressing two sides of the same coin. The puzzle of Conciliationism and Steadfastness in response to a scientific disagreement remains open, but we can now see why Steadfastness is often well justified (despite the many arguments in favour of Conciliationism), and why the pressure to conciliate sometimes overtakes.

Furthermore, there a few open issues for future research. The first one is to assess the role of the disagreement as a defeater in academic rather than public settings, as we did in this paper. Second, there is a need to integrate the peer

disagreement debate with the philosophy of science, particularly regarding the notion that the uptake of criticism is essential for scientific progress (Longino, 2002). Bringing in the results of the epistemology debate might help to clarify how exactly this uptake of criticisms should unfold – an issue that to date is unclear (Šešelja, 2021). We might, for example, claim that individual epistemic rationality is a desideratum with which we want to comply when taking up a criticism and that for these purposes scientists should always at least slightly change their position when a peer disagrees with them.

On the other hand, our contribution also challenges Conciliationism in social epistemology more generally (beyond scientific disagreements). An important line of future research could therefore be in investigating how any disagreement may rationally unfold not just with respect to the individual perspectives of the disagreeing peers but rather also with respect to the disagreeing peers being situated in a greater epistemic community. In this sense, then, Steadfastness may well turn out to be justified under specific conditions, which future research could help us better understand.

Disagreements, scientific or everyday, may then not be seen as a sign of failure but as a regular and productive part of intellectual progress – sometimes even when differing positions remain.

REFERENCES

Antiochou, K. and S. Psillos (2022). How to handle reasonable scientific disagreement: The case of COVID-19. In S. Oswald, M. Lewiński, S. Greco, and S. Villata (Eds.), The Pandemic of Argumentation, pp. 63–80. Springer.

Biddle, J. B. and A. Leuschner (2015). Climate skepticism and the manufacture of doubt: Can dissent in science be epistemically detrimental? European Journal for Philosophy of Science 5, 261–278.

Bramley, G. (2016). Structure rather than behaviour: On the causes of poverty. LSE Blog on Politics and Policy.

Brusselaers, N., D. Steadson, K. Bjorklund, S. Breland, J. S. Sörensen, A. Ewing,

S. Bergmann, and G. Steineck (2022). Evaluation of science advice during the COVID-19 pandemic in Sweden. Humanities and Social Sciences Communications 9(1).

Chinn, S. and P. S. Hart (2022). Can't you all just get along? Effects of scientific disagreement and incivility on attention to and trust in science. Science Communication 44(1), 108–129.

Christensen, D. (2007). Epistemology of disagreement: The good news. The Philosophical Review 116(2), 187–217.

Christensen, D. (2011). Disagreement, question-begging, and epistemic self-criticism. Philosophers' Imprint 11(6).

Christensen, D. (2014a). Conciliation, uniqueness and rational toxicity. Noûs 50(3), 584–603.

Christensen, D. (2014b). Disagreement and public controversy. In J. Lackey (Ed.), Essays in Collective Epistemology. Oxford University Press.

Claveau, F. (2013). The independence condition in the variety-of-evidence thesis. Philosophy of Science 80(1), 94–118.

Cocchiaro, M. Z. and B. Frances (2021). Epistemically different epistemic peers. Topoi 40, 1063–1073.

Cohen, S. (2013). A defense of the (almost) equal weight view. In D. P. Christensen and J. Lackey (Eds.), The Epistemology of Disagreement: New Essays, pp. 98–117. Oxford, UK: Oxford University Press.

Collins, H. (1981). Stages in the empirical programme of relativism. Social Studies of Science 11(1), 3–10.

Cretu, A.-M. (2020). Diagnosing disagreements: The authentication of the positron 1931–1934. Studies in History and Philosophy of Science Part B 70, 28 – 38.

Cruz, H. D. and J. D. Smedt (2013). The value of epistemic disagreement in scientific practice. the case of homo floresiensis. Studies in History and Philosophy of Science Part A 44(2), 169–177.

Dellsén, F. (2016). Scientific progress: Knowledge versus understanding. Studies in History and Philosophy of Science Part A 56, 72–83.

Dellsén, F. and M. Baghramian (2021). Disagreement in science: Introduction to the special issue. Synthese 198(Suppl 25), 6011–6021.

Elga, A. (2007). Reflection and disagreement. Noûs 41(3), 478–502.

Elga, A. (2010). How to Disagree About How to Disagree. Oxford University Press.

European Commission (2015). Grants manual - Section on: Proposal submission and evaluation.

European Commission (2020). Horizon 2020 proposal evaluation – Standard briefing.

Fleisher, W. (2021). How to endorse conciliationism. Synthese 198, 9913–9939.

Frances, B. (2010). The reflective epistemic renegade. Philosophy and Phenomenological Research 81(2), 419–463.

Frances, B. and J. Matheson (2024). Disagreement. In E. N. Zalta and U. Nodelman (Eds.), The Stanford Encyclopedia of Philosophy (Summer 2024 ed.). Metaphysics Research Lab, Stanford University.

Ioannidis, J. P. (2021). Benefit of COVID-19 vaccination accounting for potential risk compensation. npj Vaccines 6(1), 99.

Jackson, E. and G. LaFore (2024). Permissivism, underdetermination, and evidence. In C. Littlejohn and M. Lasonen-Aarnio (Eds.), The Routledge Handbook of the Philosophy of Evidence, pp. 358–370. New York: Routledge.

Kelly, T. (2010). Peer disagreement and higher order evidence. In A. I. Goldman and D. Whitcomb (Eds.), Social Epistemology: Essential Readings, pp. 183–217. Oxford University Press.

Kelly, T. (2013). Disagreement and the burdens of judgement. In D. Christensen and J. Lackey (Eds.), The Epistemology of Disagreement. Oxford University Press.

King, N. L. (2012). Disagreement: What's the problem? Or a good peer is hard to find. Philosophy and Phenomenological Research 85(2), 249–272.

Kitcher, P. (1995). The Advancement of Science. Oxford University Press.

Lackey, J. (2010). A justificationist view of disagreement's epistemic significance. In A. M. A. Haddock and D. Pritchard (Eds.), Social Epistemology, pp. 298–325. OUP.

Landes, J. (2021). The variety of evidence thesis and its independence of degrees of independence. Synthese 198(11), 10611–10641.

Lee, M. (2007). The role of the uniqueness thesis in the epistemology of disagreement. In Epistemology: Contexts, Values, Disagreement. De Gruyter.

Lewis, C. I. (1946). An Analysis of Knowledge and Valuation. Open Court.

Lindzen, R. S. and Y.-S. Choi (2011). On the observational determination of climate sensitivity and its implications. Asia-Pacific Journal of Atmospheric Sciences 47, 377–390.

Longino, H. E. (1990). Science as Social Knowledge: Values and Objectivity in Scientific Inquiry. Princeton University Press.

Longino, H. E. (2002). The Fate of Knowledge. Princeton University Press.

Matheson, J. (2009). Conciliatory views of disagreement and higher-order evidence. Episteme 6(3), 269–279.

Matheson, J. (2015). The Epistemic Significance of Disagreement. Palgrave Macmillan.

Maxim, L. and J. P. van der Sluijs (2007). Uncertainty: Cause or effect of stakeholders' debates? Analysis of a case study: The risk for honeybees of the insecticide gaucho®. Science of The Total Environment 376(1), 1 – 17.

Mayo-Wilson, C., K. J. S. Zollman, and D. Danks (2011). The independence thesis: When individual and social epistemology diverge. Philosophy of Science 78(4), 653–677.

Omitted1. Omitted. Omitted.

Omitted2. Omitted. Omitted.

Omitted3. Omitted. Omitted.

Oreskes, N. and E. M. Conway (2011). Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues From Tobacco Smoke to Global Warming. Bloomsbury Publishing USA.

Parkkinen, V., F. Russo, and C. Wallmann (2017). Scientific disagreement and evidential pluralism: Lessons from the studies on hypercholesterolemia. Humana Mente 10(32), 75–116.

Pickering, A. (1981). Constraints on controversy: The case of the magnetic monopole. Social Studies of Science 11(1), 63–93.

Pinch, T. (2015). Scientific controversies. In J. D. Wright (Ed.), International Encyclopedia of the Social and Behavioral Sciences (Second Edition ed.)., pp. 281 – 286. Oxford: Elsevier.

Polack, F. P., S. J. Thomas, N. Kitchin, J. Absalon, A. Gurtman, S. Lockhart, J. L. Perez, G. Pérez Marc, E. D. Moreira, C. Zerbini, et al. (2020). Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. New England Journal of Medicine 383(27), 2603–2615.

Santana, C. (2021). Let's not agree to disagree: The role of strategic disagreement in science. Synthese 198, 6159–6177.

Sayers, F. (2020a). Imperial's Neil Ferguson defends lockdown strategy. UnHerd.

Sayers, F. (2020b). Swedish expert: Why lockdowns are the wrong policy. UnHerd.

Science Technology UK Committee (2020). Oral evidence: UK science, research and technology capability and influence in global disease outbreaks, HC 136.

Sherwood, S. C., M. J. Webb, J. D. Annan, K. C. Armour, P. M. Forster, J. C. Hargreaves, G. Hegerl, S. A. Klein, K. D. Marvel, E. J. Rohling, et al. (2020). An assessment of Earth's climate sensitivity using multiple lines of evidence. Reviews of Geophysics 58(4), e2019RG000678.

Solomon, M. (2001). Social Empiricism. Cambridge, MA: MIT Press.

Solomon, M. (2015). Making Medical Knowledge. Oxford: Oxford University Press.

Stegenga, J. (forthcoming). Fast science. The British Journal for the Philosophy of Science.

Strevens, M. (2003). The role of the priority rule in science. The Journal of Philosophy 100(2), 55–79.

Vickers, P. (2022). Identifying Future-Proof Science. Oxford University Press.

Šešelja, D. (2021). Some lessons from simulations of scientific disagreements. Synthese 198, 6143–6158.

Whiting, D. (2021). Higher-order evidence. Analysis 80(4), 789–807.

Zollman, K. J. S. (2010). The epistemic benefit of transient diversity. Erkenntnis 72(1), 17–35.