Scientific Disagreements, Fast Science and Higher-Order Evidence

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Abstract

Scientific disagreements are an important catalyst for scientific progress. But what happens when scientists disagree amidst times of crisis, when we need quick yet reliable policy guidance? In this paper we aim to provide a normative account for how scientists facing disagreement in the context of 'fast science' should respond, and how policy makers should evaluate such disagreement. Starting from an argumentative, pragma-dialectic account of scientific controversies (Donato Rodríguez and Zamora Bonilla, 2013), we argue for the importance of 'higher-order evidence (HOE)', which has received insufficient attention in previous discussions on scientific disagreements and controversies, especially with regard to fast science. Moreover, we specify desiderata for scientifically relevant HOE. We use our account to analyze a recent disagreement on the aerosol transmission of the COVID-19 virus and evaluate the standpoints of the parties involved in the dispute.

1 Introduction

In April 2020 an interdisciplinary group of scientists – including aerosol specialists, infectious-disease researchers, and building and ventilation engineers – alerted the World Health Organization (WHO) that the COVID-19 virus appeared to be airborne (Lewis et al., 2022). Yet, it was not until October 2020 that the WHO acknowledged the aerosols may be responsible for transmission of the virus in public places, and only in December 2021 used the

term 'airborne' when describing the virus in its reports. At the time, the WHO found the evidence offered by the interdisciplinary group insufficiently convincing and stuck to its standpoint. The WHO's reaction became a matter of controversy: while critics argued the WHO was too slow to react to the arguments presented by the proponents of the aerosol hypothesis, others maintained that the response was well-paced and justified (Lewis et al., 2022).

This case presents a puzzle for philosophers of science. On the one hand, we should be able to evaluate whether the fact that the WHO held firm in the face of dissent was warranted. On the other hand, accounts of peer disagreement, which provide norms for how scientists should adjust their cognitive attitudes in case they encounter a disagreement with their peers, haven't been univocal. While some have argued that disagreeing peers need to conciliate (Elga, 2007; Christensen, 2010; Feldman, 2006; Feldman, 2007), others have defended a steadfast approach (Cruz and Smedt, 2013; Kelp and Douven, 2012; Enoch, 2010). Finally, some have suggested that different cases and contexts of disagreement may call for different verdicts (Kelly, 2010a; Konigsberg, 2012; Christensen, 2010; Douven, 2010; Lackey, 2013; Worsnip, 2014; Borge and Guercio, 2021). Importantly, the case also occurs in a specific context - namely, that of 'fast science'. However, the complications imposed by contexts of fast science have received little attention in this body of literature.

By 'fast science' we consider application-driven research confronted with an urgent need to accept or reject a certain hypothesis for the purposes of policy guidance, aimed at addressing a significant pending social harm. While recent discussions of COVID-19 have emphasized the relevance of this notion in contrast to the traditional inquiry of 'slow science' (Leite and Diele-Viegas, 2021), fast science may be triggered by other problems as well: curbing other impactful diseases that may spread far and wide, climate related issues or agricultural problems requiring quick techno-scientific solutions. For any such case to count as an instance of fast science there needs to be a scientific hypothesis that must be accepted or rejected for the purposes of immediate policy guidance (for instance, that a certain measure aimed at preventing the spread of the disease should be imposed; that the release of a certain pollutant in an ecosystem should be stopped immediately; that a certain technological innovation could prevent a pending agricultural disaster if deployed quickly). Importantly – and in contrast to regular inquiry or slow science – postponing assessment of the hypothesis to acquire additional evidence may result in significant social harm.

Our aim in this paper is to provide guidelines for how scientists and

policy makers facing disagreement under such conditions should respond, and in particular, on which kind of evidence they should base their decisions. Formulating a normative account of this kind will allow us to evaluate the steadfast response by the WHO and determine whether it was warranted. As the point of departure we will consider an argumentative, pragma-dialectic account of scientific controversies proposed by Donato Rodríguez and Zamora Bonilla, 2013 (henceforth R&B), which succinctly presents the epistemic and zetetic[1] duties of disagreeing scientists from a diachronic, argumentative point of view. We will argue that an epistemically adequate response to peer disagreement in the context of fast science must be based not only on first-order or object-level evidence (which refers to what is commonly considered scientific evidence), but also on higher-order evidence, which is evidence about evidence and the strength of epistemic position one occupies. We will then take a closer look at the case of the aerosol hypothesis, and examine whether the WHO took into account all the relevant first-order and higher-order evidence available at the time.

The paper is structured as follows. In Section 2 we provide an overview of R&B's account. In Section 3 we supplement R&B's account with an explicit focus on higher-order evidence. In Section 4 we examine the desiderata higher-order evidence needs to meet in order to count as scientifically relevant and we specify the attitude of endorsement (Lacey, 2015) as especially likely to depend on higher-order evidence in the context of fast science. In Section 5 we describe in further detail the case-study we started with, and apply our account to the WHO's response. Section 6 concludes the paper.

2 An argumentative perspective on scientific disagreements

In this section we explicate the argumentative pragma-dialectic approach to scientific disagreement developed by de Donato-Rodríguez and Zamora Bonilla (R&B) (2013). The spirit of the approach is to understand scientific disagreement with recourse to the tools of argumentation theory as well as the Brandomian idea (1994) of a game of 'giving and asking for reasons'.[2]

[1] Zetetic or inquisitive duties are those pertaining to actions an inquirer should perform in their inquiry (Fleisher, 2021). Usually these are performed with an eye towards securing some epistemic good, though there is much debate concerning the precise relationship between the epistemic and the zetetic (Friedman, 2020; Thorstad, 2022).

[2] For a related account of argumentation as an epistemic exchange see (Dutilh Novaes, 2020).

We will briefly sketch the account before turning to articulate where, as our case highlights, a theoretical lacuna remains.

R&B aim to model and provide normative guidance for when scientists, already embedded in a discursive practice, disagree. Their starting point is to see scientific discourse as just another species of any rationally evaluable normatively governed discourse. (Donato Rodríguez and Zamora Bonilla, 2013, p.43). Such discourse and the various speech-acts which compose it can be understood in part by the broader scientific practice in which it is embedded and by examining the particular 'moves' which scientists are entitled to make, i.e. the changes in deontic status they can affect. Two such examples concern 'entitlement' and 'commitment':

> On the one hand, a commitment is something that a scientist is committed to believe because it is a principle or a rule unanimously recognised as such by the community which she belongs to, or because it follows from other commitments according to the inferential rules accepted by that community. On the [other] hand, an entitlement is something legitimate for a scientist to be believed or claimed because she can provide good reasons (including, e.g., those provided by inductive methods, analogy or abduction and those provided by testimony and authority), although rejecting the same claim can also be legitimate for other members of the community. (Donato Rodríguez and Zamora Bonilla, 2013, pp. 54-55 italics in orginal)

Conceived in this way, commitment and entitlement are deontic notions: commitment indicates one's duty to provide arguments supporting one's assertions, while entitlement indicates one's permission to stand behind a given assertion in view of a previously accepted set of premises, or by providing arguments in support. The dynamics by which such deontic statuses change is governed by the internal normativity of the 'game of science' (Zamora-Bonilla, 2010).

To make good on the actual role notions like commitment and entitlement play in the progress of scientific discourse, R&B turn to draw on pragma-dialectical theories of argumentation, such as those defended by Van Eemeren and Grootendorst (1984).

Pragma-dialectics is a consensualist approach which sees successful exchange as requiring both the "protagonist" and the "antagonist" to agree on when the "protagonist" has been successful in their argumentation. Such success is determined by the rules of argumentation, which are norms that are

implicit in any critical discussion guiding the participants' exchange of ideas in order to resolve differences in opinion (Donato Rodríguez and Zamora Bonilla, 2013, p. 60). This approach will naturally connect the deontic statuses possessed by participants in a discourse with the kinds of moves their interlocutors make and whether such moves are appropriate. On this point, R&B offer norms for the retraction of standpoints, opportunities in which entitlements and commitments can be defeated:

> More exactly, in pragma-dialectics, the protagonist is only obliged to retract the initial standpoint if the antagonist has conclusively attacked it and the antagonist is obliged to retract his or her call into question if the protagonist successfully defends his standpoint ... A situation of initial disagreement does not then amount to suspend[ed] belief. (2013, p.61).

To phrase these norms in the terminology of peer disagreement, a participant in disagreement must only abandon their attitude if it has been subject to conclusive attack. Further, only upon successful defense of the disputed position must the challenge to position be abandoned.

Importantly, this position while upon first glance bearing a striking similarity to steadfast approaches to peer disagreement in epistemology, is more nuanced. In effect, the norm elides the fact of disagreement as of independent rational import, it is the content of the 'challenge' amounting to *legitimate conclusive attack*. This is in part to leave room for recognizing that what counts as a legitimate attack is judged by the standards of the given scientific practice within which a disagreement takes place, and as such it belongs to more detailed issues than their general argumentation framework aims to capture.

While R&B primarily discuss beliefs as units of appraisal, they don't address the relationship between beliefs and standpoints, which underlie van Eemeren and Grotendorst's pragma-dialectic approach and which may differ from one's beliefs. A Standpoint or a point of view is expressed with regard to a certain issue and defended by a speaker or a writer by means of argumentation, with respect to someone who doubts its acceptability or has a different standpoint (Van Eemeren and Grootendorst, 1984, p.2). A standpoint may express one's belief in a given proposition, but the degree of commitment to it "can vary from exceptionally strong, as in the case of a firm assertion, to considerably weaker, as in the case of a supposition." (Van Eemeren and Grootendorst, 1984, p. 64). This feature of pragma-dialectics is especially apt for analyzing cognitive attitudes scientists may disagree on

in the context of fast science, such as endorsing a hypothesis as a suitable basis for policy guidelines.

We find the proposal on offer a valuable contribution to characterizing disagreement within scientific discourse. What the model elides, however, is an important feature of disagreement more generally—the way in which disagreement can function as higher-order evidence (HOE). It is the lack of a specified role for HOE that leaves the pragma-dialectical model unsatisfactory to account for cases of disagreement in contexts of fast science. To see this, return to our case. The WHO, as we specified, found the evidence adduced insufficient to warrant a change of their stance towards the aerosol hypothesis. This would suggest that they considered their response to this challenge a legitimate conclusive attack. Our question, however, is whether the very fact of peer disagreement can offer here further epistemic weight merely beyond any sort of evidence eventually adduced, but weight insofar as it challenges the reliability of the assessment of evidential standing the WHO enjoys. In short, we ask, where does the epistemic weight of HOE fit into this model, and should it have played an important defeating role for the WHO's position, especially in the context of fast science? To answer this question, we first need to get clear on to what HOE amounts and how it might impact a pragma-dialectical model of scientific disagreement. It is to this task that we now turn.

3 The role of HOE

HOE receives importantly different treatment across epistemology. Here are just a smattering of recent characterizations, that HOE is:

- "Evidence about evidential relations" (Christensen, 2010)
- "Evidence about what your evidence supports" (Sliwa and Horowitz, 2015
- "Evidence about what you should believe" (Skipper and Steglich-Petersen, 2019)
- "Evidence about one's doxastic state" (Lasonen-Aarnio, 2014)
- "Evidence that concerns how rationally one has responded to one's first-order evidence" (Steglich-Petersen, 2019)
- "Evidence which bears on a believer's rational capacities, epistemic performance, or evidential situation." (Horowitz, 2022)

For our purposes we can consider higher-order evidence in line with the broad reading by Horowitz, 2022, listed last in the above overview. Our

question in this section is how HOE, understood in this way, impacts the pragma-dialectical approach to disagreement on offer.

The first thing to note is that peer disagreement is often taken to be a form of higher-order evidence itself (see e.g. Christensen, 2010, Kelly, 2010b). That is, the fact that a peer, someone equally competent and with equal access to the evidence disagrees with one suggests that one may have misjudged their epistemic performance or evidential situation.[3] Whether, and to what extent this kind of evidence should impact one's doxastic attitude has been a matter of philosophical debates. A recent discussion by Henderson, 2022 provides a helpful summary by distinguishing between 'Revise' and 'Level-splitting' views. According to the former, HOE merits a revision of both higher-order attitudes and first-order attitudes,[4] on the latter one's epistemic levels are split such that HOE affects higher-order attitudes without having evidential import for the first order attitudes. So, depending on how one views the force of HOE, one will see its impact in cases of disagreement as calling for more or less revision about the matter at hand.

Similarly, whether HOE should play a role in how scientists adjust their attitudes when their peers disagree with them has also been a contested issue (see e.g. Straßer et al., 2015, Borge and Guercio, 2021). Our aim in this section is not to argue in favor of a specific weight of HOE, relative to the weight of first-order evidence (FOE). Rather, we wish to argue that HOE plays a relevant role in the pragma-dialectical model of disagreement, which has so far remained unrecognized. We will take a closer look at the exact role and the weight of HOE relative to other reasons in the next section.

Our thought is that HOE needs to be understood as part and parcel of what a disputant in any debate to which the pragma-dialectical model applies, need consider. In this way, and under specific conditions, the very fact of disagreement can serve to challenge the standing a protagonist has towards the claim they offer. In particular, if one party in a dispute provides arguments that amount to a 'conclusive attack' in view of the FOE, HOE may challenge such conclusiveness. For instance, if a scientific community is divided on the accuracy of a certain hypothesis, where one party dismisses

[3]Note however that examples of HOE do not depend on the presence of disagreement: a number of cases discussed in the literature concern a single agent who obtains evidence that, for instance, they have consumed a substance which tends to impair one's reasoning. This information serves as HOE about their epistemic position.

[4]A first-order attitude is a doxastic attitude towards first-order propositions, which are those that concern ordinary subject matter in the world. In contrast, higher-order attitudes are directed towards higher-order propositions, which concern doxastic states or attitudes of an agent, including the relationship between evidence and an agent's doxastic state (Henderson, 2022, p. 3).

the opponents' arguments as too weak in view of what they consider to be relevant FOE (e.g. previous studies, experimental results, etc.), their position may still remained challenged by the relevant HOE (such as the very fact of disagreement in the field). In the next section we discuss under which conditions HOE plays such a role. For now, we can express the revised norms of the pragma-dialectical model as follows:

Protagonist Retraction: A protagonist is obliged to retract her initial standpoint to the extent she has received FOE or HOE undermining her epistemic standing.

Antagonist Retraction: The antagonist is obligated to retract her attack to the extent the protagonist successfully defends her standpoint from both FOE and HOE.

These norms offer a natural extension of the central deontic concepts of the pragma-dialectical framework in such a way as incorporates HOE. They offer general normative guidance in cases of disagreement. Our focus, however, is a specialized context so we turn now to examine desiderata on good HOE for scientific disagreement.

4 Scientifically Relevant HOE

Not all HOE is equally valuable, for scientific disagreements or otherwise. In this section we spell out additional features of the kind of HOE most useful to scientists disagreeing in the context of fast science. To start, consider the following case from the research on genetically modified organisms (GMOs) and their safety.

In 2015, a number of scientists affiliated with the European Network of Scientists for Social and Environmental Responsibility (ENSSER) together with co-authors from across the world, published a joint statement, arguing that there is no scientific consensus on the safety of genetically modified crops and foods produced with them, and that more research needed to be done to establish the safety of GMOs (Hilbeck et al., 2015). The authors wrote that the joint statement was "developed and signed by over 300 independent researchers" (p. 1), that is, "by scientists from around the world in their personal (rather than institutional) capacities reflecting their personal views and based on their personal expertise." (p. 4). This seems to indicate that the list of signatories of the joint statement provides evidence of expert disagreement and consequently HOE undermining claims of GMO safety.

Nevertheless, as criteria for expertise (and thus inclusion on the list) the authors list the following:

> Qualifying criteria for signing the statement were deliberately selected to include scientists, physicians, social scientists, academics, and specialists in legal aspects and risk assessment of GM crops and foods. Scientist and academic signatories were requested to have qualifications from accredited institutions at the level of PhD or equivalent. Legal experts were requested to have at least a JD or equivalent. By December 2013, more than 300 people who met the strict qualification requirements had signed the statement. (Hilbeck et al., 2015, p. 5)

This means that among the signatories were indeed some experts on GMO's, but also members of the broader scientific community who might fail to have expertise in biomedical sciences, let alone regarding GMOs and food safety. The opinion of scientists with no expertise in the given matter fails to constitute relevant evidence. Any higher-order evidential force this letter might possess as an attestation of expert opinion, is thus significantly diminished. Accordingly, this case illustrates a failed attempt at acquiring scientifically relevant HOE by means of expert endorsement. Moreover, it raises the question: what constitutes scientifically relevant HOE? We now turn to this question and specify a set of desiderata for scientifically relevant HOE.

4.1 Desiderata for scientifically relevant HOE

First, HOE worth its salt will be garnered from epistemically respectable sources. Let us call this the *Relevant Expertise Criterion*. For instance, the testimony of an expert on a certain gene-sequencing technique is, other things equal, of more pertinent relevance than that of a newcomer to the relevant debates. Assessing the relevant track-records of possible sources is no easy task but is a matter science as an institution has, in principle, ways of highlighting and with which practicing scientists are certainly familiar. If the ENSSER letter had been signed by all and only experts on GMO's and food safety, it would have been epistemically useful in the context of disagreement.

Furthermore, the method of acquiring HOE needs itself to have meritorious epistemic credentials. Call this the *Good Acquisition Criterion*. Taking just as seriously the testimony of scientists as offered in a short PR release

by a pharmaceutical company versus testimony acquired from an open letter signed by scientists in "Nature" would be a dangerous game. For a more realistic example, the testimony of well-placed peers as reported in generalist venues or popular science communications would offer weaker HOE than if the same testimony were acquired first-hand, for instance, from a specialist article authored by the given scientists. So good HOE in these contexts will be obtained via epistemically respectable methods.

Good HOE here will also meet a number of subsequent conditions. It will fail to possess any indication that its formation is the result of epistemically deleterious groupthink, or conformity bias (Solomon, 2006). At best, HOE will possess indication that it has been produced in the opposite way, that is by a group whose deliberations promote and preserve opportunities for dissent (for example, by being produced within a group that employs experts of diverse and relevant backgrounds, having no known conflicts of interest, and who have varied research experience). Similarly, ensuring a diversity of opinions are appropriately addressed, will also be another relevant factor that increases the quality of scientifically relevant HOE. Call this the *Diversity Criterion*.[5]

Finally, the more experts in support of the given standpoint there are, the stronger the HOE is. Call this criterion the *Scope* of the HOE.

4.2 The weight of HOE and the scientific endorsement

The above list of desiderata should not be understood as necessary conditions for scientifically relevant HOE. Rather, they provide the basis for assessing the strength of given HOE and the degree to which it is scientifically relevant. So what does this mean for the role of HOE in scientific disagreements? Our take is that HOE should impact one's first-order attitudes depending on its relative strength in the context of other epistemic reasons. In some situations, such as regular inquiry (or 'slow science'), HOE may be outweighed by much stronger first-order considerations. Moreover, since scientists are not pressed to accept or reject hypotheses, they may also suspend their judgment until they acquire sufficiently strong FOE. As a result, scientists may postpone making assessments that underly certain cognitive attitudes, such as accepting or rejecting a hypothesis for purposes of policy guidance.

[5]This criterion is closely related to the principle of independence, often discussed in the literature on peer-disagreement, see e.g Christensen, 2009: "In evaluating the epistemic credentials of another person's belief about P, to determine how (if at all) to modify one's own belief about P, one should do so in a way that is independent of the reasoning behind one's own initial belief about P." (p. 758).

The context of fast science is, however, such that scientists do not have the luxury of waiting for additional evidence before deciding to accept a certain hypothesis or not. In particular, fast science comes with pressure on scientists to make assessments that underly the attitude that Lacey, 2015 has called an 'endorsement':

> To endorse claim p = to treat p – after considering the consequences of accepting p, should it be false, and their ethical salience (in comparison with that of the consequences of not accepting p, should it be true) – as being supported by evidence that is sufficiently strong that the legitimacy of courses of action (or regulation/policy making), informed by it, should not be challenged on the ground that p has insufficient empirical support. Lacey, 2015, p. 93

The context of fast science demands the attitudes of endorsement be made even in face of the lacking or weak FOE. In such situations HOE may provide a valuable source of additional epistemic reasons. For example, it may indicate that the space of potential defeaters of a hypothesis that is best supported by FOE is still open (for instance, due to an ongoing inquiry). This may suggest that the hypothesis shouldn't be endorsed since the policies based on it could soon end up being challenged on empirical grounds (once the additional evidence is available). As Lacey argues, a responsible endorsement of a hypothesis will ultimately be a matter of both epistemic and non-epistemic reasons, where the epistemic uncertainty has to be weighed against the non-epistemic consequences of error. What we wish to emphasize is that during the times of fast science epistemic reasons may be hard to come by, which is why scientifically relevant HOE should inform attitudes of endorsement in accordance with its relative strength.

What about the role of HOE in other contexts and with respect to other doxastic attitudes? In line with our elaboration of the pragma-dialectic account of disagreements, there is no reason why other doxastic attitudes (expressing one's standpoint in a debate) should not be informed by HOE, though its impact should depend on its relative strength in the overall space of epistemic reasons. Hence, whether HOE will result in Protagonist or Antagonist Retraction, will depend on specifics of the case. What makes the context of fast science and the attitudes of endorsement particularly interesting is that they are likely to be accompanied by relatively weak FOE. As a result, the role of HOE becomes especially relevant in situations that involve these constraints.

This leaves us with a question, however. Aren't considerations based on HOE already part of scientific deliberation and decision-making? In the next section we return to our case from above, the disagreement over aerosol transmission of COVID-19. With the fully elucidated pragma-dialectic framework and an account scientifically relevant HOE on the table, we are now in a position to diagnose where scientists involved in this dispute went wrong and answer this question.

5 Aerosol transmission of COVID-19 redux

Before we evaluate the stance of the WHO on the hypothesis of aerosol transmission, we look into the background of the debate in further detail.

5.1 The controversy

At the time of controversy over the transmission of the COVID-19 virus, three broad models of viral transmission were discussed: droplet transmission, fomite transmission, and airborne transmission (World Health Organization, 2020a).

On the first model of transmission, droplets are expelled from infected individuals and enter the systems of others. Droplet transmission occurs primarily within close contact and much of the strategy for fighting the pandemic turned on reducing the conditions ripe for droplet transmission – masks and social distancing.

On the second model of transmission, non-infected persons come into direct contact with infectious persons, or with contaminated surfaces. Strategies to avoid fomite transmission in the early pandemic involved wiping down potentially contaminated surfaces and avoiding close contact.

The third model of transmission, however, was seen as less of an immediate threat in everyday contexts. On this mode, viral particles were transmitted via the air and could linger for long periods of time. What was pertinent for the WHO's deliberations was that no studies had been able to culture the virus from contaminated air particles (Wilson et al., 2020). This, in turn, suggested to the WHO that airborne path was a less significant modality of transmission.

A number of scientists found this response problematic, not least because culturing the virus from contaminated air particles was not expected to be quick and easy (Lewis et al., 2022; Jimenez et al., 2022; Randall et al., 2021). A lack of immediate results here need not have been surprising,

let alone decisive evidence against aerosol transmission. In light of these concerns, an international, interdisciplinary group of scientists started to communicate and share their views.[6] Subsequently, a joint commentary signed by 239 "infectious-disease physicians, epidemiologists, engineers and aerosol scientists" (Lewis, 2020) was published on July 6, 2020 (Morawska and Milton, 2020). The commentary argued that aerosol transmission was a real threat and urged the WHO to introduce precautionary measures based on this path of transmission. The broad thrust of the response was the following:

- Previous studies have shown that "viruses are released during exhalation, talking, and coughing in microdroplets small enough to remain aloft in air and pose a risk of exposure at distances beyond 1–2 m from an infected individual" (Morawska and Milton, 2020, p. 2311).
- Previous studies of SARS-CoV-1, a predecessor of COVID-19 "demonstrated that airborne transmission was the most likely mechanism explaining the spatial pattern of infections" (Ibid.).
- Studies of particular instances of the spread of COVID-19 (for example, based on the analysis of video records from a restaurant) support the hypothesis of aerosol transmission of COVID-19.
- The evidence for the aerosol transmission of COVID-19 is incomplete, but the evidential status of the other two modes of transmission – the large droplet and the fomite modes – is similar.
- In light of this evidence, the public guidance should be based on precautionary measures, including effective ventilation, avoiding overcrowding, and so forth (p. 2312).

The WHO responded by acknowledging that aerosols couldn't be ruled out, especially in poorly ventilated places. In the updated brief from July 2020, the WHO stated that "SARS-CoV-2 is primarily transmitted between people via respiratory droplets and contact routes – although aerosolization in medical settings where aerosol generating procedures are used is also another possible mode of transmission" (World Health Organization, 2020b, p. 4). However, it retained the recommendation that keeping physical distance is the main preventive measure in public places, advising people to wear fabric face masks "where there is community transmission [...] and where other prevention measures, such as physical distancing, are not possible" (Ibid.). By not including measures based on the aerosol hypothesis

[6]For a personal account of Linsey Marr, an aerosol scientist at Virginia Tech who was one of the central contributors to the discussion, see Molteni, 2021.

(such as effective ventilation in public buildings, based on airborne infection controls, or N95 face masks), the WHO refused to endorse it as the basis for policy guidance, even though many of the suggested measures were easy to implement and not particularly costly.

It is with this backdrop that we are finally in a position to assess whether the WHO responded appropriately in this disagreement.

5.2 Our assessment of the WHO's standpoint

We can reconstruct the debate in terms of the above pragma-dialectic account, where the WHO plays the role of the protagonist and the proponents of the aerosol hypothesis play the role of the antagonist. The WHO's standpoint on the aerosol hypothesis in July 2020, after the publication of Morawska and Milton's open letter, can be characterized as the rejection to endorse the hypothesis with respect to the COVID-19 transmission in public places. Put in Lacey's terms (see above Section 4.2) the WHO treated the evidence supporting the aerosol hypothesis as not being sufficiently strong to warrant the legitimacy of policy-making informed by it. The assessment of the strength of the evidence had to be done in view of the non-epistemic consequences of accepting the hypothesis, in case it would have turned out to be false (such as the costs of effective ventilation, the cost of N95 masks in contrast to fabric masks and so forth), as well as the non-epistemic consequences of rejecting the hypothesis in case it would have turned out to be true after all (such as the failure to prevent the spread of the virus and possibly save lives).

Recall that according to the norm 'Protagonist Retraction', the protagonist is obliged to retract the initial standpoint to the extent she has received FOE or HOE undermining her epistemic standing. The WHO's policy guidelines for public spaces were based on the endorsement of the droplet and the fomite modes of transmission, leaving the aerosol mode for specific medical settings. On the one hand, the WHO received FOE, summarized in Morawska and Milton's open letter. However, this evidence was considered weak (Lewis et al., 2022). For instance, in August 2020, another commentary was published on behalf of the WHO's 'Infection Prevention and Control Research and Development Expert Group for COVID-19',[7] stating that the primary routes of COVID-19 transmission are respiratory droplets and close

[7]Among the authors of the commentary are also members of the Infection Prevention and Control Guidance Development Group (IPC GDG), consisting of "about 40 clinicians and researchers that advises the WHO on infection containment, especially in hospitals" (Lewis et al., 2022).)

contact, and adding that "based on the scientific evidence accumulated to date, our view is that SARS-CoV-2 is not spread by the airborne route to any significant extent" (Conly et al., 2020, p. 1).

However the WHO also received HOE: Morawska and Milton's 2020 commentary. This document, signed by over 200 scientists with relevant expertise, is evidence of the disagreement between a part of the scientific community and the WHO. As such, it provides HOE challenging the stance of the latter. Based on the criteria proposed in Section 4, this is scientifically relevant HOE. First, the signatories of the document are scientists with relevant expertise concerning the spread of aerosols,[8] satisfying the Relevant Expertise Criterion. Second, the commentary was published in *Clinical Infectious Diseases*, which is one of the leading journals in the field of infectious diseases.[9] This fulfills our Good Acquisition Criterion. Finally, the fact the group of signatories is interdisciplinary and international strongly supports our Diversity Criterion, while the large number of scientists indicates the Scope of the HOE is relatively large as well.

Whether the WHO should have revised its position already in view of FOE is a question that goes beyond the scope of this paper. Our aim here is to argue that even if the FOE was insufficiently convincing to change its standpoint, there was still HOE the WHO failed to take into account. Since the WHO received scientifically relevant HOE undermining its epistemic standing, which it had no reason to dismiss, it was obliged to retract its standpoint. In particular, it was obliged to revise its endorsement of the relevant transmission paths of COVID-19 in public places and at least mention the guidelines that would lower the risk of aerosol transmission in public settings. By not adequately revising its endorsement of the relevant modes of the virus transmission, the WHO failed to act according to the above norm.[10] Indeed, it was only in October 2020 that the WHO acknowledged

[8]The affiliations of all the signatories are provided in the Supplementary Data, accompanying Morawska and Milton's commentary.

[9]For instance, according to the *Journal Citation Reports* by Clarivate, 2022, the journal's impact factor for 2021 was 20.999, ranking it 6^{th} out of 94 journals in the category 'Infectious Diseases' (taken from https://academic.oup.com/cid/pages/About, accessed on October 2, 2022.)

[10]Our pargma-dialectic account is also compatible with Lacey's own take on what counts as *serious endorsement*: "p is seriously endorsed if and only if it can plausibly be portrayed as satisfying two conditions: First, its endorsement is based on outcomes of inclusive research in which [...] the interests of all relevant parties to obtain empirical data are taken into account; and, second, the proposals (regarding p) of each party to the research are subject to criticism on the basis of the strongest empirical evidence that can be obtained in the context of the time frame available, and in the light of evidence considered relevant by the critics." (Lacey, 2015, p. 93). While Lacey doesn't mention HOE, adding it would

that the aerosol transmission was happening outside of medical settings and updated its policy guidelines (Lewis et al., 2022).[11]

5.3 Discussion

The above analysis has focused on the disagreement between a part of the scientific community and the WHO. But what about other public health institutions? Did they fare any better in their update of policy guidelines? And isn't our assessment simply uncharitable: after all, the WHO did revise its guidelines in October 2020, so why should have it revised them sooner than that? We close this section by addressing these two questions.

Concerning the former issue, at the Centers for Disease Control and Prevention (CDC) in the United States, the situation was not any better. Until September 2020 the CDC maintained that COVID-19 was primarily spread through close contact, from person to person. On September 18, 2020, the CDC finally published an update on its website, for the first time mentioning aerosol transmission. Just three days later this information was removed: the CDC explained that a draft version had been posted in error and that further updates would follow (see e.g. Tanne, 2020), suggesting the CDC considered the aerosol hypothesis controversial.[12] On October 5, 2020 an adjusted version of the information concerning the spread of the virus was published, stating that COVID-19 "can sometimes be spread by airborne transmission".[13]

This indicates that the public health institutions primarily based their

supplement his account in the similar way as we have done with the pragma-dialectic approach. The main reason why we have employed the latter is to allow for a sufficiently broad take on disagreements during fast-science, which may also include other cognitive attitudes, beside the attitude of endorsement.

[11]For a historical explanation of the WHO's resistance towards the aerosol hypothesis see (Jimenez et al., 2022; Randall et al., 2021) who root the problem in the decades long dismissal of the airborne transmission of diseases and a mistaken measure of aerosol particles, used to distinguish them from larger droplets, which had become entrenched in the medical community.

[12]A question one may ask at this point is: wasn't the attitude of the CDC supporting HOE for the WHO (and the other way around)? Our answer is that such an agreement indeed plays the role of HOE. However, it doesn't undermine the force of HOE obtained by the Morawska and Milton's commentary, given the number of the signatories and their expertise on the matter. For HOE to be rejected, one needs reasons pertinent to it specifically, rather than different HOE in support of one's view. Given the Scope of the HOE in this particular case, we do not consider the stance of CDC to play such a defeating role.

[13]How COVID-19 Spreads accessed via web.archive.org for October 5, 2020 (accessed on October 2, 2022).

scientific endorsement on FOE, as it is usually done in the context of slow science. Even if one disagrees with particularities of our assessment in this case, our main point is to draw attention to the importance of HOE in the context of fast science.

Concerning the second issue from above – whether the WHO (as well as the CDC) revised their standpoints quickly enough – we have to emphasize that we are analyzing the context of fast science, where policy guidelines may have to be adjusted daily, given the epidemiological circumstances and incoming scientific evidence. The fact that the WHO did provide an updated scientific brief in view of the objections raised by the aerosol scientists, suggests they did react to it. However, as we have argued, they failed to consider HOE as a relevant type of evidence that should have further informed their revised stance. Given the stakes, a revised stance on the precautionary measures in line with the aerosol hypothesis was already required in July 2020, rather than two or three months later.

6 Conclusion

In this paper we have aimed to provide a normative account of scientific disagreement in the context of fast science. For this, we have used a pragma-dialectic take on scientific disagreements by (Donato Rodríguez and Zamora Bonilla, 2013), and enhanced it with the notion of higher-order evidence (HOE). Furthermore, we have provided criteria for assessing whether certain HOE is scientifically relevant. By applying our account to the recent controversy concerning the aerosol hypothesis of COVID-19 transmission, we have provided an explanation of why the stance by the WHO was unwarranted, and what its stance should have been instead. While our account may equally apply to scientific disagreements in the context of 'slow science', the relevance of HOE may not be as pronounced in such cases as it can be in fast-scientific-disagreements.[14] In any case, with this revised framework in hand we are in a better position to analyze scientific disagreements, the bearing of relevant evidence, and the degree to which each party in the debate's standpoint is warranted.

[14]See, for example, Borge and Guercio, 2021.

References

Borge, Bruno and Nicolás Lo Guercio (2021). "Learning from Scientific Disagreement". In: *THEORIA. An International Journal for Theory, History and Foundations of Science*.

Brandom, Robert (1994). *Making it explicit: Reasoning, representing, and discursive commitment*. Harvard university press.

Christensen, David (2009). "Disagreement as Evidence: The Epistemology of Controversy". In: *Philosophy Compass* 4.5, pp. 756–767.

— (2010). "Higher-Order Evidence". In: *Philosophy and Phenomenological Research* 81.1, pp. 185–215.

Conly, John, WH Seto, Didier Pittet, Alison Holmes, May Chu, and Paul R Hunter (2020). "Use of medical face masks versus particulate respirators as a component of personal protective equipment for health care workers in the context of the COVID-19 pandemic". In: *Antimicrobial Resistance & Infection Control* 9.1, pp. 1–7. DOI: https://doi.org/10.1186/s13756-020-00779-6.

Cruz, Helen De and Johan De Smedt (2013). "The value of epistemic disagreement in scientific practice. The case of Homo floresiensis". In: *Studies in History and Philosophy of Science Part A* 44.2, pp. 169–177.

Donato Rodríguez, Xavier de and Jesús Zamora Bonilla (2013). "Scientific Controversies and the Ethics of Arguing and Belief in the Face of Rational Disagreement". In: *Argumentation* 28.1, pp. 39–65. DOI: 10.1007/s10503-013-9300-4. URL: http://dx.doi.org/10.1007/s10503-013-9300-4.

Douven, Igor (2010). "Simulating peer disagreements". In: *Studies in History and Philosophy of Science Part A* 41.2, pp. 148–157.

Dutilh Novaes, Catarina (2020). "The role of trust in argumentation". In: *Informal Logic* 40.2, pp. 205–236.

Elga, Adam (2007). "Reflection and disagreement". In: *Noûs* 41.3, pp. 478–502.

Enoch, David (2010). "Not Just a Truthometer: Taking Oneself Seriously (but Not Too Seriously) in Cases of Peer Disagreement". In: *Mind* 119.476, pp. 953–997. DOI: 10.1093/mind/fzq070.

Feldman, R. (2007). "Reasonable Religious Disagreements". In: *Philosophers without Gods*. Ed. by L. M. Antony. OUP, pp. 194–214.

Feldman, Richard (2006). "Epistemological Puzzles About Disagreement". In: *Epistemology Futures*. Oxford University Press, pp. 216–326.

Fleisher, Will (2021). "Pursuit and Inquisitive Reasons". In: *Forthcoming*.

Friedman, Jane (2020). "The epistemic and the zetetic". In: *Philosophical review* 129.4, pp. 501–536.

Henderson, Leah (2022). "Higher-Order Evidence and Losing One's Conviction". In: *Noûs*. DOI: 10.1111/nous.12367.

Hilbeck, Angela, Rosa Binimelis, Nicolas Defarge, Ricarda Steinbrecher, Andras Sezkacs, Fern Wickson, Michael Antoniou, Phillip L. Bereano, Ethel Ann Clark, Michael Hansen, Eva Novotny, Jack Heinemann, Hartmut Meyer, Vandana Shiva, and Brian Wynne (2015). "No Scientific Consensus on GMO Safety". In: *Environmental Sciences Europe* 27 (4).

Horowitz, Sophie (2022). "Higher-Order Evidence". In: *The Stanford Encyclopedia of Philosophy*. Ed. by Edward N. Zalta and Uri Nodelman. Fall 2022. Metaphysics Research Lab, Stanford University.

Jimenez, Jose L, Linsey C Marr, Katherine Randall, Edward Thomas Ewing, Zeynep Tufekci, Trish Greenhalgh, Raymond Tellier, Julian W Tang, Yuguo Li, Lidia Morawska, et al. (2022). "What were the historical reasons for the resistance to recognizing airborne transmission during the COVID-19 pandemic?" In: *Indoor air* 32.8, e13070.

Kelly, Thomas (2010a). "Peer disagreement and higher order evidence". In: *Social Epistemology: Essential Readings*, pp. 183–217.

— (2010b). "Peer Disagreement and Higher-Order Evidence". In: *Disagreement*. Ed. by Richard Feldman and Ted A. Warfield. Oxford: Oxford University Press, pp. 111 –174.

Kelp, C. and I. Douven (2012). "Sustaining a Rational Disagreement". In: *EPSA Philosophy of Science: Amsterdam 2009*, pp. 101–110.

Konigsberg, Amir (2012). "The Problem with Uniform Solutions to Peer Disagreement". In: *Theoria*.

Lacey, Hugh (2015). "'Holding'and 'endorsing'claims in the course of scientific activities". In: *Studies in History and Philosophy of Science Part A* 53, pp. 89–95.

Lackey, Jennifer (2013). "Disagreement and Belief Dependence: Why Numbers Matter". In: *The Epistemology of Disagreement: New Essays*. Ed. by David Phiroze Christensen and Jennifer Lackey. Oxford, UK: Oxford University Press, pp. 243–268.

Lasonen-Aarnio, Maria (2014). "Higher-Order Evidence and the Limits of Defeat". In: *Philosophy and Phenomenological Research* 88.2, pp. 314–345.

Leite, Luciana and Luisa Maria Diele-Viegas (2021). "Juggling slow and fast science". In: *Nature Human Behaviour* 5.4, pp. 409–409.

Lewis, Dyani (2020). "Mounting evidence suggests coronavirus is airborne—but health advice has not caught up". In: *Nature* 583.7817, pp. 510–513.

Lewis, Dyani et al. (2022). "Why the WHO took two years to say COVID is airborne". In: *Nature* 604.7904, pp. 26–31.

Molteni, Megan (2021). "The 60-year-old scientific screwup that helped COVID kill". In: *Wired, May 13*. Accessed on October 2, 2022. URL: https://www.wired.com/story/the-teeny-tiny-scientific-screwup-that-helped-covid-kill/.

Morawska, Lidia and Donald K Milton (2020). "It is time to address airborne transmission of coronavirus disease 2019 (COVID-19)". In: *Clinical Infectious Diseases* 71.9, pp. 2311–2313.

Randall, Katherine, E Thomas Ewing, Linsey C Marr, JL Jimenez, and Lydia Bourouiba (2021). "How did we get here: what are droplets and aerosols and how far do they go? A historical perspective on the transmission of respiratory infectious diseases". In: *Interface Focus* 11.6, p. 20210049.

Skipper, Mattias and Asbjø Steglich-Petersen (2019). *Higher-order evidence: New essays*. Oxford University Press.

Sliwa, Paulina and Sophie Horowitz (2015). "Respecting all the evidence". In: *Philosophical Studies* 172.11, pp. 2835–2858.

Solomon, Miriam (2006). "Groupthink versus The Wisdom of Crowds: The Social Epistemology of Deliberation and Dissent". In: *The Southern Journal of Philosophy* 44, 28–42.

Steglich-Petersen, Asbjørn (2019). "Higher-Order Defeat and Doxastic Resilience". In: *Higher-Order Evidence: New Essays*. Ed. by Mattias Skipper and Asbjørn Steglich-Petersen. Oxford University Press.

Straßer, Christian, Dunja Šešelja, and Jan Willem Wieland (2015). "Withstanding Tensions: Scientific Disagreement and Epistemic Tolerance". In: *Heuristic Reasoning*. Ed. by Emiliano Ippoliti. Studies in Applied Philosophy, Epistemology and Rational Ethics. Springer, pp. 113–146.

Tanne, Janice Hopkins (2020). "Covid-19: CDC publishes then withdraws information on aerosol transmission". In: *BMJ* 370. DOI: 10.1136/bmj.m3739. eprint: https://www.bmj.com/content/370/bmj.m3739.full.pdf. URL: https://www.bmj.com/content/370/bmj.m3739.

Thorstad, David (2022). "There Are No Epistemic Norms of Inquiry". In: *Synthese* 200.5, pp. 1–24. DOI: 10.1007/s11229-022-03896-4.

Van Eemeren, Frans H van and Rob Grootendorst (1984). *Speech acts in argumentative discussions*. De Gruyter Mouton.

Wilson, Nick, Stephen Corbett, and Euan Tovey (2020). "Airborne transmission of covid-19". In: *BMJ* 370. DOI: 10.1136/bmj.m3206. eprint:

https://www.bmj.com/content/370/bmj.m3206.full.pdf. URL: https://www.bmj.com/content/370/bmj.m3206.

World Health Organization (2020a). *Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations: scientific brief, 27 March 2020*. Technical documents, 3 p.

— (2020b). *Transmission of SARS-CoV-2: implications for infection prevention precautions: scientific brief, 09 July 2020*. Tech. rep. World Health Organization.

Worsnip, Alex (2014). "Disagreement About Disagreement? What Disagreement About Disagreement?" In: *Philosophers' Imprint* 14.

Zamora-Bonilla, Jesús (2010). "What Games Do Scientists Play? Rationality and Objectivity in a Game-Theoretic Approach to the Social Construction of Scientific Knowledge". English. In: *EPSA Epistemology and Methodology of Science*. Ed. by Mauricio Suárez, Mauro Dorato, and Miklós Rédei. Springer Netherlands, pp. 323–332. ISBN: 978-90-481-3262-1. DOI: 10.1007/978-90-481-3263-8_28. URL: http://dx.doi.org/10.1007/978-90-481-3263-8_28.