# Distributive Epistemic Justice in Science*

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**Abstract**

This article develops an account of distributive epistemic justice in the production of scientific knowledge. We identify four requirements: (a) science should produce the knowledge citizens need in order to reason about the common good, their individual good and pursuit thereof; (b) science should produce the knowledge those serving the public need to pursue justice effectively; (c) science should be organized in such a way that it does not aid the wilful manufacturing of ignorance; and (d) when making decisions about epistemic risks, scientists should make sure that there aren't social groups or weighty interests that are neglected. After discussing these requirements, we examine the relationship between discriminatory and distributive epistemic injustice in science and argue that they often compound each other.

## 1 Introduction

In her ground-breaking book *Epistemic Injustice: Power and the Ethics of Knowing* [2007], Miranda Fricker introduced the idea of epistemic injustice and distinguished between testimonial and hermeneutical injustices. Testimonial injustice arises when a speaker is wronged by a hearer who assigns a deflated level of credibility to the former's assertion due to prejudice against their social identity. Hermeneutical injustice arises when a someone is deprived of conceptual resources that enable them and others to make sense of their individual experiences due to hermeneutical marginalization in society. In her book, Fricker considered the unfair distribution of epistemic goods such as education and information but only to set it aside as not being 'distinctively epistemic' (Fricker [2007], p. 1).

However, David Coady forcefully argued that unjust distributions of epistemic goods were epistemic injustices since 'it is not at all incidental that epistemic goods, such as information and education, can be characterised as epistemic' ([2010], p.

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101). Such injustices, he argued, were irreducible to other distributive injustices and mattered much in the same way as unjust distribution of economic goods. Hence, Coady formulated distributive epistemic injustice as 'injustice in the distribution of the epistemic good of knowledge' (Coady [2010], p. 112). As a result, Fricker extended her conceptualization of epistemic injustice to cover distributive epistemic injustice, by which she means 'someone's receiving less than their fair share of an epistemic good such as education, or access to expert advice or information' (Fricker [2017], p. 53).

Thus, the question of epistemic injustice in science can be approached from two perspectives: the perspective of discriminatory epistemic injustice, a broader category Fricker later adopts to describe testimonial and hermeneutical injustices, and the perspective of distributive epistemic injustice. There is a growing body of research on discriminatory epistemic injustice in science. In addition to Heidi Grasswick's [2017] general account of the phenomenon, there are studies that examine it in the context of specific sciences and their applications, such as medicine and psychiatry, and proposals for remedying it (Carel and Kidd [2014], Bueter [2019], Crichton et al. [2017], Koskinen and Rolin [2019]). Distributive epistemic in/justice in science, however, remains under-theorized. Although we owe the concept of distributive epistemic injustice to the exchange between Fricker and Coady, they have not developed it beyond the general formulation given above, much less to apply it to scientific knowledge production. In fact, Coady explicitly says that questions about the correct principles of distributive epistemic justice are beyond the scope of his paper (Coady [2010], p. 104).[1]

Earlier several philosophers discussed this issue in the context of access to information without, though, employing the apt concept of distributive epistemic justice. For example, Jeroen van den Hoven and Emma Rooksby (2008) have argued that access to 'informative objects' such as books and databases is a primary good in the Rawlsian sense and therefore subject to Rawls' principles of distributive justice. Don Fallis has explored how different theories of justice could be incorporated into Goldman's veritistic social epistemology (Fallis [2007]).

One shortcoming of this literature has been its focus on the dissemination of existing knowledge and the concomitant neglect of prior questions regarding the production of knowledge. This makes them ill-suited to the study of distributive epistemic in/justice in science. The framework recently offered by Faik Kurtulmus and Gürol Irzik [2017] and Kurtulmus [2020] remedies this to a significant extent. They argue that that although knowledge, understood as true belief, is a primary good, the object of distributive justice is the opportunity to acquire knowledge one

[1] In a later publication Coady argues that both testimonial and hermeneutical injustices are actually distributive in nature since the former involves an unfair distribution of credibility and the latter involves 'unequal access to participation in the generation of social meanings' (Coady [2017], p. 65). While there is certainly room for a discussion of distributive epistemic in/justice within the scientific community from this perspective, our approach is different in that we are primarily concerned with the structural features of scientific knowledge production in relation to the knowledge needs of citizens and public officials. See below.

has an objective interest in. The distribution of the opportunity to acquire knowledge is determined by 'the epistemic basic structure of a society', which is the set of institutions responsible for the production and dissemination of knowledge as well as ensuring that people can assimilate this knowledge. While their framework explicitly includes science as a major institution for knowledge production, their discussion of it is limited.

This article aims to fill this lacuna by presenting an overview of the ways in which distributive epistemic justice plays out in scientific knowledge production. In Section 2 we summarize Kurtulmus and Irzik's framework. In Section 3 we distinguish between primary and secondary distributive epistemic injustices in science: while the former occurs when science fails to provide citizens with an equal opportunity obtain the knowledge they need, the latter arises when it fails to provide officials with the knowledge necessary for the pursuit of justice. We illustrate these in Sections 4 and 5 respectively. In Section 6 we discuss how the use of science for wilful manufacturing of ignorance constitutes yet another form of distributive injustice. In Section 7 we argue that the inductive and epistemic risks in scientific research also give rise to claims of distributive epistemic justice. One of the key lessons that emerge from paying attention to distributive epistemic in/justice in science is that different forms of epistemic injustice can interact with and compound each other. In Section 8 we show how various forms of discriminatory injustice are related to distributive epistemic injustice in science. We conclude by noting the holistic nature of distributive epistemic justice in science: achieving it is not just a matter of the proper functioning of the institution of science, but of the epistemic basic structure as a whole.

## 2 The Epistemic Basic Structure and Justice

Kurtulmus and Irzik define the epistemic basic structure of a society as those institutions that have the greatest impact on people's opportunity to acquire knowledge on issues they have an objective interest in as individuals, citizens and public officials. The epistemic basic structure is responsible for the distribution of the opportunity to acquire knowledge. This involves three processes: the production of knowledge, its dissemination, and ensuring that people have the capability to assimilate what is disseminated by providing them with the necessary educational background and intellectual skills. Throughout this paper, when we speak of the distribution of knowledge or the distribution of the opportunity to acquire knowledge, we refer to the outcome of all three processes, not just to the dissemination of existing knowledge.

The epistemic basic structure includes institutions of science and education, media, search engines, public libraries, museums, and various governmental offices that carry out research such as the Bureau of Labor Statistics and the Food and Drug Administration in the USA. These institutions are naturally bound by the principles of justice, such as non-discrimination and respect for individuals' rights,

that apply to all social institutions. Kurtulmus and Irzik argue that there are at least two further requirements of justice that apply specifically to the epistemic basic structure. First, it should serve individuals fairly and provide them with an equal opportunity to gain knowledge in order to reason about the common good, their individual good and pursuit thereof unless there are overriding reasons for an unequal distribution. Knowledge is no less important than material resources in enabling individuals to lead flourishing lives and exercise their rights effectively. Lack of knowledge about how to protect one's health can harm a person just as lack of access to healthcare does. Similarly, lack of knowledge can hinder the effective exercise of a person's political rights as much as lack of economic resources. While people do have some epistemic agency and responsibility, they are dependent on the epistemic basic structure of their society: if the knowledge people need is not produced or not disseminated in a way they can access or if they lack the necessary education to understand what is disseminated, their ability to reflect on and pursue their individual ends and the common good will be harmed.

Second, the epistemic basic structure should produce and disseminate the knowledge public officials need for the design and effective implementation of just laws and policies. The pursuit of justice in the economic sphere, the pursuit of equality of opportunity, the provision of healthcare to citizens, the protection of the environment, and the reliable functioning of the criminal justice system all depend on legislators and public officials having the requisite knowledge.

By knowledge Kurtulmus and Irzik mean true belief, that is, they adopt Goldman's account of weak knowledge and follow him in being concerned primarily with truth in assessing social institutions from an epistemic perspective [1999].[2] However, even if the epistemic basic structure functions well and individuals do their best, it is impossible to guarantee that they will always end up with knowledge in this sense. This is in part because scientific inquiry is fallible. Nevertheless, when conducted well, scientific research can be reliable in the sense that its findings have a high probability of being true. Indeed, the more reliable the research people have access to, the greater their chances of attaining true beliefs. Hence, while the ultimate goal of the epistemic basic structure should be to provide citizens with the opportunity to acquire knowledge in the sense of true beliefs, science policies that aim at it will seek to promote reliable inquiry.

Kurtulmus and Irzik do not offer an in-depth account of the demands of distributive epistemic justice that fall on specific institutions that make up the epistemic basic structure. As we shall demonstrate, there is much to be gained from attending to their particularities.[3] In this paper we provide an overview of what distributive epistemic justice requires of science as a source of knowledge for citizens

[2]For their rationale see Kurtulmus and Irzik [2017], p. 130.

[3]The use of Kurtulmus and Irzik's Rawls-inspired framework does not commit us to either ideal or non-ideal theorizing. They are engaged in what Hamlin and Stemplowska call 'a theory of ideals', which aims 'to identify, elucidate and clarify the nature of an ideal or ideals' ([2012], p. 53). As they point out, with a theory of an ideal at hand, one can inquire into how it can be pursued in ideal or non-ideal conditions.

and public officials who serve them. This requires attending to research agendas and practices, the application of scientific research and the institutional context that shapes them. There are also issues of distributive epistemic justice within the scientific community. The accessibility of data, the intellectual property rights regime as it relates to scientific research, and the commercial model of academic publishing all give rise to issues of distributive epistemic injustice within science. While these are certainly important and interact with our question of how fairly science serves society, we leave them out for reasons of scope.

## 3 Primary and Secondary Distributive Epistemic Justice

We find it helpful to distinguish between two kinds of injustice that pertain to the distribution of scientific knowledge. Primary distributive epistemic justice is concerned with the knowledge ordinary citizens need. It requires that science produce reliable research that meets knowledge needs of all groups in a society regardless of their race, ethnicity, class, religion, and gender. If a society has the necessary resources but its scientific institutions do not provide knowledge people have an objective interest in or does so unfairly, giving undue priority to some over others, then the ensuing deprivation of the opportunity to acquire knowledge itself constitutes an injustice that we call 'primary distributive epistemic injustice'.

Primary distributive epistemic justice does not require that everyone should always enjoy an equal opportunity to have knowledge. Other demands of justice may provide overriding reasons for an unequal distribution. Inequalities are also permissible when they are necessary for an efficient division of epistemic labour in society that benefits everyone or for the effective pursuit of public goals. For this reason, it is not unjust, for example, if scientists or public officials enjoy better opportunities to acquire knowledge in order to carry out their specialized tasks.

'Secondary distributive epistemic justice' is concerned with the production of scientific knowledge public officials need for carrying out their tasks required by justice, such as providing health care, designing and implementing effective social and environmental policies, and maintaining a fair legal system. Injustice in this context arises when public officials commit or fail to remedy injustices because of a lack of scientific knowledge due to a poor or unfair social organization of scientific research.

Primary and secondary distributive epistemic injustice can come about because of the way scientific research agendas are set and how research is conducted. Thus, an account of distributive epistemic justice will be incomplete if it is only concerned with the dissemination of existing knowledge. It has to take the production of knowledge into account. It is here that science plays a crucial role.

Distributive epistemic justice does not apply to all scientific knowledge. Inequalities in the opportunity to acquire knowledge or the absence of research about, for instance, the formation of black holes is not an injustice. More generally, scientific research that has no impact on individual welfare or public policy does not

give rise to claims of justice. It is the connection between the need for knowledge and already existing requirements of justice that give rise to questions of distributive epistemic justice. The underlying thought can be summed up as follows: Whenever (i) there is a reason of justice to take public action to protect or promote certain individual interests; and (ii) the provision of knowledge to individuals or to public officials who serve them can help protect or promote those interests, there is a *pro tanto* reason of justice for the provision of this knowledge—which means there is a *pro tanto* reason to produce and disseminate it and enable people to make use of it.

For this reason, the question of which specific epistemic needs of citizens and society as a whole ground claims of justice, and which needs have priority should be settled with reference to a general theory of distributive justice. There can be accounts based on, for instance, Sen and Nussbaum's capabilities approach or welfarist prioritarianism. Kurtulmus and Irzik adopt Rawls's theory of justice. They argue that knowledge that bears on individuals' life plans and deliberations about the common good is a primary good and its distribution a matter of justice. Furthermore, they hold that the epistemic basic structure should aid the pursuit of Rawls's principles of justice (Kurtulmus [2020]; Kurtulmus and Irzik [2017]). In what follows, we present cases involving individuals' epistemic needs that bear on people's health and the quality of their environment, and social policies that shape the economy, environmental regulations and healthcare. These are all scientific issues most theories of distributive justice will recognize as morally significant.

Inequalities or lack of knowledge due to what might be called epistemic bad luck are also not unjust.[4] Some facts are harder than others to discover because of the way the world is or because of our current stock of scientific knowledge. Sometimes, there are good faith errors in scientific research. Inequalities arising from such factors are unfortunate but do not constitute distributive epistemic injustice.[5]

## 4 Producing Knowledge People Need

We have claimed that it is a requirement of primary distributive epistemic justice that science produce the knowledge ordinary citizens need in their deliberations about the common good, their personal good and their pursuit. In this context scientific knowledge ordinary citizens rely on does not have to be extensive or deep. It is the type of knowledge expressed in such statements as 'Smoking causes lung cancer', 'The mumps-measles-rubella vaccine is generally safe and effective', 'Wearing a mask and physical distancing help reduce the spreading of the COVID-19', 'Burning fossil fuel contributes to environmental pollution and global warming' and the like. To the extent that such statements are derived from scientific research, they do embody scientific knowledge, albeit in a simple and condensed form that the public

[4]We thank one of the referees of this journal for this suggestion.

[5]It's worth noting a certain difficulty. Given that our current stock of knowledge is influenced by past choices which may reflect various injustices, current difficulties may not always exculpate and may require remedial action.

can understand and use in making their life plans. The type and depth of scientific knowledge laypeople need will be no doubt relative to their purposes. Generally speaking, ordinary citizens do not need to know the research behind it. Yet the scientific research that supports it needs to exist. If it is lacking or unreliable or based on populations different from them in significant ways—and is, hence inapplicable or misleading for them—their epistemic needs will not be served.

Institutions of science serve primary distributive epistemic justice through the production of knowledge. However, their role is not limited to this. Without claiming to be exhaustive, we note two further duties. The dissemination of scientific knowledge to citizens will be mostly through the media and the education system. Nevertheless, the chain of communication starts with scientists, often through press releases issued by university press offices. Scientists and their institutions have a duty to make their initial communications accurate and informative for the public, paying due attention to their epistemic needs. If these initial statements are exaggerated, as a recent study suggests they are, then the public will not be properly informed (Sumner et al. [2014]).

Reliable scientific research and its accurate dissemination is not sufficient to ensure its uptake by members of the public. They also have to trust scientists. For this to be the case, science should not only be trustworthy, but also seen to be trustworthy. Thus, the organization of science should signal its trustworthiness to the public by minimizing conflicts of interest and demonstrating scientists' adherence to the norms of science.

Addressing the needs of victims of what Grasswick calls 'epistemic trust injustice' requires further steps. Epistemic trust injustices occur when some people, due to past interactions with experts, have reasons to distrust them. For instance, given the history of research abuse, like the notorious Tuskegee Syphilis Study, African Americans have reasons to be distrustful of medical researchers and doctors. This makes it harder for them to benefit from the information provided to them (Grasswick [2018]). In such cases, bringing about distributive epistemic justice requires taking the necessary steps to enable African Americans to have well-placed trust in medical professionals and medical research.

To make the idea of primary distributive epistemic justice in science more concrete and illustrate the complex questions that arise in this context, we present the U.S. Environmental Protection Agency's (EPA) hazard assessment in New Orleans in the aftermath of Hurricane Katrina.[6] Hurricane Katrina had carried, along with salt water, sediments and chemicals that were possibly toxic. The residents of the neighbourhoods who were considering returning to their homes depended on the EPA's research for finding out if it was safe to do so. The EPA did extensive testing in the flooded parts of New Orleans collecting approximately 1,800 sediment and soil samples and carrying out analyses for the presence of almost 200 contam-

[6]Scott Frickel and his collaborators have studied the EPA's effort with a view to assessing how well it has served the public's informational needs (Frickel, Campanella, et al. [2009]; Frickel and Vincent [2011]; Frickel and Edwards [2014]). We follow their account.

inants. However, their 'knowledge investments'—'the time, money, technologies, expertise and other resources that EPA expended in collecting soil and sediment samples, returning to sampling locations for follow-up sampling, and performing tests on the sampled material'—was not evenly distributed across neighbourhoods (Frickel, Campanella, et al. [2009], p. 123). Contrary to what one might expect, there was more knowledge investment in poorer and disproportionately African American neighbourhoods.

This was not because these neighbourhoods suffered disproportionately from flooding. The unequal distribution of knowledge investments was an outcome of the EPA's sampling strategies and public pressure. After an initial citywide round of sample collection and testing, the EPA focused its efforts on a few hotspots. These were either sites that contained chemical concentrations that, under existing regulatory standards, required further action or pre-existing hazardous waste sites that were the subject of public concern. This did not mean that neighbourhoods not singled out as hotspots were free of chemicals. Many of them had heavy metals and industrial chemicals in their soil but at lower levels. There were also several areas that were not sampled at all. Given that many of these hotspots were neighbourhoods already known to contain hazardous waste-sites, Frickel and colleagues argue, the EPA's testing strategies did not provide the residents of these neighbourhoods with much new information (Frickel, Campanella, et al. [2009], p. 131). The residents of neighbourhoods that received less knowledge investment also were not well-served. Obviously, people in neighbourhoods where no samples were collected did not receive any information. People in neighbourhoods where testing stopped after the first round of sample collection and testing also could not be confident that it was safe to return to their homes. The EPA's testing strategy, in effect, sought to minimize false positives by stopping testing in neighbourhoods where they did not find contaminants at levels high enough to trigger further action.

The failure to satisfactorily inform the residents of New Orleans about the safety of returning was not solely due to the EPA. The EPA did not have peer reviewed studies for the carcinogenicity of 70% of the contaminants found in New Orleans. Thus, Frickel and Vincent maintain that 'despite official assurances to the contrary, no one really knows what hazards remain' ([2011], p. 12).

This case contains several lessons regarding primary distributive epistemic injustice. First, it is not easy to determine when there is such an injustice.[7] While knowledge investments were distributed unequally across different neighbourhoods, we cannot conclude that this was unjust. What fundamentally matters is not the distribution of knowledge investments but whether the residents' epistemic needs were served fairly. The right amount of knowledge investment depends on what was already known and what was found out during research. The fair distribution of knowledge investments would be one that enabled everyone to determine whether it was safe to return to their homes. Second, inequalities in the distribution of knowl-

[7]Frickel and colleagues are attuned to the normative complexity of the case and warn against drawing hasty normative conclusions (Frickel, Campanella, et al. [2009], p. 130).

edge can be the unintended outcome of policies and protocols that are determined by their own logic. The EPA did not ask how much research it should allocate per resident or per residential neighbourhood or how best it could serve the epistemic needs of the residents of New Orleans. It followed a set of pre-defined sampling and testing procedures for allocating research investments guided by the EPA's institutional mandate shaped by its own organizational priorities. Third, in line with this second observation, distributive epistemic justice does not always track other injustices. In this case, for instance, it was disadvantaged neighbourhoods that received more knowledge investment. This should not surprise us. Even though existing inequalities and relations of power influence the science that gets done, internal factors—such as the current state of scientific knowledge, the availability of research methods and tools, and what is seen as epistemically significant—also play a role. Finally, just focusing on inequalities in research allocation at the point where it is being directly applied would be short-sighted. As Frickel and Vincent note, solid research on the carcinogenicity of many of the contaminants found in New Orleans was lacking. Thus, even if the EPA took steps to serve every resident fairly there would still be a distributive epistemic injustice.

One final clarification is necessary. Primary distributive justice does not require that the knowledge needs of citizens should be satisfied no matter what. We may decide, on reflection, that it would be too costly to determine the safety of all neighbourhoods and that resources should be allocated to other more urgent needs. This would not mean that primary distributive epistemic justice does not matter. People who could not find out if their neighbourhoods were safe or not would be due some compensation because their justice based demands had not been fulfilled. A consideration of justice that is outweighed by other such considerations still retains some force.

## 5 Producing Knowledge Public Officials Need

The vast portion of the knowledge produced by science is highly technical and of no direct use to laypeople. Ordinary citizens do not need to have deep or extensive knowledge of medicine when they suffer from a health problem, their doctors do; the knowledge forensic science provides, such as how blood and DNA analyses can be used as evidence in courts, is needed by judges and lawyers more than ordinary citizens; the same point applies to knowledge social sciences provide for social policy. All of these types of expert knowledge are crucial to the effective pursuit of justice and benefit ordinary people indirectly. Therefore, justice requires that science produce knowledge needed by public officials for the purposes of providing health care, criminal justice, effective design and implementation of social policies.

Science can be a source of secondary distributive epistemic justice because it plays a pivotal role in policy. If public officials lack the knowledge necessary for the pursuit of justice, their efforts will be ineffective. If they act on unreliable or biased research, they may commit injustices. Very often, a social problem becomes a

public concern only when it is documented by scientific evidence (Weingart [1999], p. 155). If science neglects the interests of certain groups, the problems that plague them are unlikely to be addressed. Thus, a theory of distributive epistemic justice in science has to be attentive to science's role in the formulation and implementation of public policy.

Scientific research agendas must be set in such a way that the production of knowledge that would benefit disadvantaged groups is not neglected. Consider disparities in medical research. There is 'a lack of a concerted research and development effort to improve diagnostic testing methods or drugs and vaccine' for some tropical and parasitic diseases that inflict especially the poor and people of African descent in the USA (Hotez [2009]). This constitutes a distributive epistemic injustice, given that the United States has all the means to fill this knowledge gap.

Not just the allocation of resources but the design of clinical trials and the analysis of data can be sources of distributive epistemic injustice. Perhaps the best-known example in this context is research on coronary heart disease. Even though it has been and still is the leading cause of death for women in the USA, it was considered a 'man's disease' until the 1990s. For this reason, women were either completely excluded from or underrepresented in relevant research populations. The well-known 'The Physicians' Health Study' that investigated the effect of low-dose aspirin on heart attack was carried out only on men. Based on the study, aspirin has been routinely recommended for the primary prevention of heart attacks. That this recommendation did not apply to women was discovered only after a study was carried out on exclusively women subjects. It concluded that aspirin has no such effect on women if they are below 65 (Criado-Perez [2019], pp. 217–8).[8]

As we observed in the previous section, distributive epistemic injustices do not always track other patterns of inequality. The under-diagnosis of osteoporosis in men provides further illustration. If someone has a bone mineral density 2.5 standard deviations below that of the mean of the reference group, they are diagnosed with osteoporosis. The reference group up until 1997 was white women aged 20–29 years. This practice changed in 1997 thanks to data collected by the CDC. When a reference group of males was used to diagnose osteoporosis in men, its estimated prevalence in men went from 1%–4% to 3%–6% (Schiebinger and Klinge [2013], pp. 92–5).

These examples illustrate the disparate ways in which different groups face secondary distributive epistemic injustice. In all of these cases, the medical profession lacked the necessary knowledge that would benefit their patients. The ultimate cause was the poor social organization of medical research that prioritized the health needs of some groups over others or neglected relevant differences.

Medical and drug research is, of course, not the only kind of research required for the pursuit of justice. Social sciences are particularly relevant to the identifica-

[8]These are not isolated cases. Dusenbery [2018], Criado-Perez [2019], Schiebinger [2020] and the literature cited therein, present many other examples of gender bias in the production of scientific knowledge especially in medicine but not confined to it and discuss the reasons behind the gendered knowledge gap.

tion and overcoming of injustices in the distribution of opportunities, income and wealth. Research in forensic science and psychology are crucial for the criminal justice system. Scientific research relevant to the pursuit of justice will not be limited to disciplines that directly contribute to policies because they often depend on research across several disciplines that may appear very distant from policy. For instance, forensic evidence such as DNA analysis that courts rely on is based on the life sciences. Thus, the requirements of secondary distributive epistemic justice will fall on many scientific disciplines.

It may be suggested that what we have called secondary distributive epistemic injustice is not really an epistemic injustice because knowledge figures only as a means to the realization of justice. It is true that injustices of this type do not wrong individuals as knowers. However, their contribution to injustice is distinctly epistemic: they are injustices societies commit or fail to remedy because of a lack of knowledge. In certain instances, science is uniquely positioned to further or hinder the pursuit of justice. To use the language of economics, scientific knowledge is not always a substitutable input in the pursuit of justice. Certain social injustices are discoverable only through scientific inquiry. If the public is unaware of an injustice because the research that would uncover it is lacking, they cannot address it. Or if existing research has failed to take the needs of certain groups into account, as in the case of some health research, policies that aim to serve everyone fairly will fail. In all of these cases, the scientific research that has been done or is lacking will play an essential causal role in the existence of these non-epistemic injustices. Whatever name we give them, the remedy will involve attending to the production of scientific knowledge.

The boundaries between primary and secondary distributive epistemic injustices are not too sharp in practice even though they are conceptually distinct. The line between what officials serving the public need to know and what members of the public need to know is sensitive to contextual factors—in particular, the division of labour in a society. If people are carrying out a certain task themselves, they will need to have the knowledge necessary for it. If there are specialized people who are carrying out this task for them, it will be the specialists who need the knowledge. People will only need to know how to identify competent specialists and how to effectively interact with them. Compare these two different ways of ensuring that people do not suffer from a certain disease. In the first, individuals take a preventative measure that protects them against the disease. In the second, they don't take such a measure, but doctors treat the disease. Unfairness in the production of scientific knowledge in the first case would be an instance of primary distributive epistemic injustice; in the second case it would be an instance of secondary distributive epistemic injustice.

## 6 The Injustice of Producing Ignorance

Distributive epistemic injustice occurs not just when science fails to produce knowledge ordinary citizens and public officials need. It can also come about through the suppression of existing knowledge or the wilful manufacturing of ignorance. These are receiving increasing attention from historians and philosophers of science in the newly emerging field of agnotology (see Proctor and Schiebinger [2008]; Kourany and Carrier [2020]). The tobacco industry's strategy of deliberate suppression of scientific knowledge and manufacturing of ignorance by producing unreasonable doubt about smoking's causing lung cancer provides a well-documented example of this phenomenon (Oreskes and Conway [2011]; Galison and Proctor [2020]).[9] Our account below relies on this body of research.

The year 1953 was a watershed both for medical research and the tobacco industry in the US. Researchers had obtained significant evidence linking smoking to lung cancer. They had found that cigarette tar applied to the skin of mice caused deadly cancers. Within less than a decade the medical research community established beyond any reasonable doubt that smoking was a major cause of lung cancer. The US surgeon general's report of 1964 announced the emerging consensus to the public.

Since the 1953 finding was widely covered in the media, the tobacco industry immediately organized to defend itself by setting up a public relations program. The overall strategy of the program was to create unreasonable doubt about the causal relation between smoking and cancer. The program was headed by eminent scientists, first by Clarence C. Little, a geneticist who was a member of the National Academy of Sciences, and then by Frederick Seitz, a physicist who was the president of the National Academy of Sciences in the 1960s. Their strategy had three pillars.

The first pillar consisted of supporting what Robert Proctor calls 'distraction science' (Galison and Proctor [2020], p. 29). This means funding research not about the impact of tobacco on health, but rather about other possible causes of cancer. Such research was then used to argue that because cancer could have other causes and not everybody who smokes gets it, science had not yet 'proven' the required causation.

The second pillar was to handpick some scientists, promote their tobacco industry friendly views and employ them as witnesses in courts. To give just one example, in a famous court case against Philip Morris in 1997, Martin Cline, a distinguished biomedical researcher at the UCLA's medical school, testified that although smoking is linked to certain types of cancer at the population level, there was no scientific evidence at the individual level. During the trial Cline admitted that he received three million dollars from the tobacco industry to support his research.

The final pillar consisted of disseminating the fruits of the first two to doctors, journalists, and Congress members to inform them that there was 'another side'.

[9] Deliberate production of ignorance using science is not confined to the smoking-cancer example. It extends to acid rain, the ozone hole, global warming, and packaged food. See (Oreskes and Conway [2011] and Moss [2013]).

The media, which adhered to the supposedly objective practice of balanced reporting, was thereby made to serve the tobacco industry's ends. Journalists presented both sides of the issue regarding smoking-cancer link as if they were equally supported by evidence.

This three-pillar strategy succeeded in creating significant doubt in the minds of ordinary citizens well into the 1980s, thus contributing to primary distributive epistemic injustice. But to the extent it delayed the decisions of the courts and the Congress, it further caused a secondary distributive epistemic injustice. The Congress waited until 2009 to authorize the FDA to regulate tobacco as an addictive drug, and the tobacco industry was found guilty for scheming to deceive consumers just three years earlier. Their researchers knew already back in the early 1960s that smoking caused cancer, in addition to being addictive because of the nicotine it contains. The wrong done to the public was clearly epistemic, but the harm it caused was deadly.

The tobacco industry's strategy to mislead the public and public officials reveals an important point: justice in the production of science is not just about the conduct of individual researchers. What matters is the overall pattern of scientific research that emerges. Individual conduct, which is not problematic when viewed in isolation, may be troublesome as part of a broader pattern. The public and its officials may be misled —without any researcher committing fraud or engaging in questionable research practices—through selective support for and selective sharing of some research (Weatherall et al. [2020]). In other words, the account of distributive epistemic justice we develop in this article is what Elizabeth Anderson calls a 'structural theory'. It seeks to provide 'criteria for assessing global properties of a system of rules that govern transactions and imposes constraints on permissible rules with an eye toward controlling the cumulative effects of individual transactions that may be innocent from a local point of view' (Anderson [2012], p. 164). Thus, the thought is not that each researcher should ask themselves 'What research should I do to serve justice?'. Such an approach would face insurmountable coordination problems and be unhelpful. Rather, the structural factors that shape scientific research (such as funding decisions, the incentive system of science, journal policies, the distribution of opportunities that determines who gets to be a scientist, and so on) should be organized in such a way that science serves justice.

## 7 Justice in Epistemic Risk Distribution

Following Rudner [1953], Heather Douglas has argued that values play an ineliminable role in science [2009]. Inductive inferences always come with the risk of rejecting a true hypothesis or accepting a false hypothesis. Since often we cannot minimize both risks at the same time, we need to choose one of them to minimize. This choice will reflect our value assessment of the consequences of the two types of errors. Biddle and Kukla have argued that the risk of error is not limited to inductive inferences [2017]. The operationalization of concepts, the inclusion or exclusion of

borderline data points, the choice of models, diagnostic criteria for medical conditions all face risks of error. Thus, they argue for the existence of 'epistemic risk', a broader category which encompasses 'any risk of epistemic error that arises anywhere during knowledge practices' (Biddle and Kukla [2017], p. 218). Since people may have competing interests in avoiding certain kinds of errors, or the policies that are based on different epistemic risk judgments may impact their interests differently, the assignment of epistemic risk also raises questions of distributive epistemic justice.

Recall that in Sections 4 and 5 we focused on two roles played by science: providing individuals with the knowledge they need and providing public officials with the knowledge necessary for the pursuit of justice. In both of these roles, justice bears on how epistemic risks should be assigned. The importance of avoiding certain erroneous beliefs may not be the same for all individuals. When this is the case, scientists' choice of how to allocate epistemic risk will affect individuals' comparative opportunity to acquire knowledge they need. A fine-tuned approach looking at every individual's claims and every proposition would be hopelessly complicated and inefficient. Rather, we should seek to avoid systemic injustices. We should consider whether there are groups or weighty interests that are neglected when scientists assign epistemic risks. Since epistemic risk management is 'often embedded in institutional practices and structures', the problem should be tackled through attending to the underlying social forces that shape this process, such as sources of funding and who gets to participate in science (Biddle and Kukla [2017], p. 217; see also Wilholt [2013].

How epistemic risks are assigned in scientific research that informs public policy can directly impact public welfare and cause secondary distributive epistemic injustices (Elliott [2011]). The epistemic risk involved in diagnosing heart attack provides an example. If the criteria for it are specified too narrowly, one can miss genuine heart attacks and fail to treat them. If they are specified too broadly, one wrongly characterizes someone as having a heart attack, causing unnecessary anxiety and treatment. Hence, as Biddle and Kukla point out, the choice of diagnostic criteria carries epistemic risk ([2017], p. 229). Until recently, such criteria for heart attack were based on typical symptoms experienced by men, such as crushing chest pain and shooting pain down the left arm. As it turns out, in addition to chest pain which is typical, women can have a number of different symptoms such as pain in the neck and throat, nausea and vomiting, dizziness and even insomnia. As a result, doctors have tended to mis- or under-diagnose and consequently undertreat women's heart problems (Dusenbery [2018], pp. 219–20; Criado-Perez [2019], pp. 217–9; Schiebinger [2020], p. 281). The root of the harm done to women in this context is a clear case of an unfair epistemic risk distribution: Diagnostic criteria for heart attack were defined too narrowly in favour of men.

The unfairness of epistemic risk distribution in the diagnosis of heart disease is not limited to the criteria for heart attacks. Standard diagnostic tools such as electrocardiogram, stress tests and even angiography are also less conclusive in women compared to men (Criado-Perez [2019], p. 219; Schiebinger [2020], p. 282). This

systemic problem has structural causes rooted in the way medical profession has historically arisen and developed. In a nutshell, it was due to taking males as 'the prototype of the human research subject' (Dresser [1992], p. 27). The exclusion of women from research populations and the ensuing 'knowledge gap' has been systemic and not unique to the study of coronary heart diseases (DeBruin [1994]; Dresser [1992]; Schiebinger [2014]). Even when women are included in clinical studies, scientists do not always carry out gender analysis of their data to see if the gender of the research subjects affects the findings. Since the problem is structural, it needs to be addressed accordingly.[10]

Questions of justice also arise for the allocation of epistemic risk in research that will be an input to public policy because it influences how effectively a society complies with the requirements of justice. Suppose that scientists adopt a very high standard for accepting and asserting that a certain chemical is harmful to public health. Their adoption of this standard will make it less likely that its use will be restricted. Or suppose that scientists opt for a narrow definition of a given disease. This will mean that many people who would otherwise receive treatment will not (Biddle [2016]). In both of these cases, insofar as scientists' assignment of epistemic risk neglects or undervalues social ends that have priority, their research will hinder the pursuit of justice. These choices regarding epistemic risk come prior to deliberation about public policies and the identification of injustices that need to be corrected. For this reason, they can be hard to detect even though they can have substantial effects. Theories of justice that do not attend to the production of scientific knowledge will fail to account for them.

## 8 Discriminatory and Distributive Epistemic Injustice in Science

Several philosophers have noted that testimonial injustice occurs in medical settings, when health professionals 'allow a negative stereotype of illness to prejudice their perception and evaluation of the credibility of an ill speaker' (Carel and Kidd [2017], p. 338). Doctors sometimes dismiss female patients' reports of their symptoms due to 'cultural stereotypes regarding femininity' (Grasswick [2017], p. 315). This kind of testimonial injustice does not only affect those whose testimony is disregarded; it affects all future patients like them since valuable medical information is cast aside as irrelevant. This contributes to the existing knowledge gap regarding women's health and thereby to distributive epistemic injustice. The dialectic here works in the other direction as well. The testimonial injustice suffered by female patients is exacerbated by the existing distributive epistemic injustice in medicine. When doctors are not trained about the differences in the way men and women experience certain disease symptoms, when the medical establishment is impaired by the systemic knowledge gap more generally, testimonial injustice becomes highly

[10]For attempts in this direction, see Schiebinger [2020], pp. 294–7 Schiebinger [2020] and the literature cited therein.

likely. Therefore, we should be vigilant about the possible interactions between discriminatory injustices, like testimonial injustice, and distributive epistemic injustices since one may compound the other.[11]

Testimonial and hermeneutical injustices are not the only discriminatory epistemic injustices. Suppose a teacher fails to uptake a student's questions or suggestions intended as a contribution to an ongoing discussion due to prejudice or stereotype. This is a distinct discriminatory injustice: the student does not necessarily suffer from a credibility deficit or lack of conceptual resources (Hookway [2010]). Grasswick calls such injustices 'participatory epistemic injustices' since some one's 'capacity to contribute to cooperative inquiry as an epistemic agent is stymied' (Grasswick [2017], p. 316). She notes that such injustices can also occur in the context of science and distinguishes between two types. First, it can occur within the scientific community when some scientists do not give due attention or credit to other scientists because of prejudice, stereotype, gender or racial bias.[12] Second, it can occur when scientists ignore laypeople's relevant 'local knowledge' in their interactions with them (Grasswick [2017], pp. 317–8).

Participatory injustices in science, whether against other scientists or laypeople, can cause distributive epistemic injustice. Consider Grasswick's ([2017]) example of the latter: the interactions between UK scientists and sheep farmers in Cumbria following the Chernobyl disaster. Wynne's case study, which Grasswick draws from, demonstrates this. Scientists ignored sheep farmers' knowledge about local environmental conditions and sheep behaviour due to their prejudice against them as epistemic agents (Wynne [1992], Wynne [1998]). This participatory epistemic injustice, in turn, caused a distributive one: because they did not take sheep farmers' local knowledge into account, scientists understood the effects of the radioactive fallout on sheep farming in Cumbria poorly. While the farmers' local knowledge was certainly not scientific, scientists' ignoring it made their knowledge of the effects of radioactive fallout in complex natural environmental conditions unreliable. As a result, both the relevant scientific community and the people living in the area were unfairly deprived of valuable scientific knowledge.

Participatory injustices within the scientific community cause distributive epistemic justices because who gets to fully participate in science affects both what is researched and how it is researched. Such injustices harm not only the scientists who cannot participate fully in scientific research, but also members of the public who would benefit from their contributions.

Participatory injustices affect what gets researched because scientists pursue not just any truth but scientifically significant truths. As Kitcher has argued, what counts as a scientifically significant question is not context-independent. It is shaped, in part, by the social and ethical values of scientists and the society they belong to (Kitcher [2001], pp. 63–82). When there is participatory injustice within a research

[11] A similar point is also made by (Anderson [2012], p. 169 and Koskinen and Rolin [2019], p. 1059).

[12] Since injustices within the community of scientists is largely beyond the scope of our paper, we leave this issue aside.

community, some groups have less power to shape what counts as scientifically significant—either because they are underrepresented in the community or because their voices are not heard. Judgments of scientific significance that influence which research is valued and pursued, end up reflecting the interests and needs of some groups over others, resulting in distributive epistemic injustice.

Participatory injustice within science also influences the conduct of research. It can, for instance, affect the operationalization of scientific concepts. Consider the history of the operationalization of gross domestic product (GDP), which has become a standard measure for the economic performance of countries. As feminist economists have pointed out, GDP primarily measures market production and excludes unpaid care work, which is often done by women (Waring [1988]). Remarkably, this criticism has existed since the initial development of GDP. Phyllis Deane, who was working closely with the economists who developed the modern method of national income accounting and GDP, had argued for, and devised ways to measure, the inclusion of home production. When the United Nations adopted the System of National Accounts, this critique was not heeded. While the participatory injustice women economists suffered is probably not the only reason, Luke Messac's research suggests that it played a role. The expert committees who devised the international standards for national income accounting had few female members—and it was the women members of these committees who emphasized the importance of incorporating household production in GDP (Messac [2018]). Given the centrality of GDP to public discourse, this way of counting domestic production has shaped public policy. It has also meant unpaid care work went unrecognized and those who carried it out lacked an economic measure of their contributions. In this instance, participatory injustice within the scientific community contributed to secondary distributive epistemic injustice.

## 9 Conclusion

In this article we have focused on one aspect of distributive epistemic justice in science, namely, the requirements of justice in the production of scientific knowledge. We have identified several distinct ways in which injustices can occur in this context: by systematically failing to meet the knowledge needs of ordinary citizens and public officials who serve them; by enabling the production of ignorance; and by unfair management of epistemic risks. Moreover, we have underlined how distributive, testimonial and participatory injustices may feedback onto each other.

Primary distributive epistemic justice is about people's opportunity to acquire knowledge. Suppose the institutions of science do their part. People may still not enjoy their fair share of the opportunity to acquire knowledge. This knowledge may not be disseminated fairly and reliably. Or people may lack the education that would enable them to make use of the knowledge offered them. Thus, institutions of media and education also play a crucial role in determining people's opportunity to acquire knowledge. The tobacco industry's deliberate manufacturing of ignorance

by creating unreasonable doubt in the minds of the public provides a good example of how all three processes are involved. As we have seen, there was well-conducted scientific research on the impact of smoking on lung cancer. The injustice incurred on citizens was, rather, largely due to the tobacco industry's bombarding them as well as health professionals, members of the Congress and above all journalists with 'distraction science'. The US media's so-called 'balanced reporting' played a major role in confusing the public. A more nuanced science reporting is no doubt essential for distributive epistemic justice. This case also draws our attention to the importance of education. A public better educated about how science works, the basics of causation, and which experts to trust would certainly be less influenced by strategic ploys of the kind made by the tobacco industry.

Secondary distributive epistemic justice, which is about the knowledge needs of those who serve the public, also depends on the well-functioning of the epistemic basic structure as a whole. Consider the gender disparities in health research discussed in Section 5. Individual researchers cannot, by themselves, change research priorities. Funding bodies and regulatory agencies need to fund and incentivize research to address these disparities. Journals should encourage the gender analysis of data. Such improvements will not change medical practice unless the results of studies that pay attention to gender differences are incorporated into the medical curriculum.

This is just another way of saying that distributive epistemic justice in science is a holistic matter. Achieving it depends on the fair organization and the well-functioning not just of the institution of science, but also of the epistemic basic structure as a whole.

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