SOCIAL AND COGNITIVE DIVERSITY IN SCIENCE:

INTRODUCTION

To be published in *Synthese* 202, 36 (2023).

https://doi.org/10.1007/s11229-023-04261-9

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Abstract: In this introduction to the Topical Collection on *Social and Cognitive Diversity in Science*, we map the questions that have guided social epistemological approaches to diversity in science. Both social and cognitive diversity of different types is claimed to be epistemically beneficial. The challenge is to understand how an increase in a group's diversity can bring about epistemic benefits and whether there are limits beyond which diversity can no longer improve a group's epistemic performance. The contributions to the Topical Collection discuss various proposals to maintain an appropriate amount of cognitive diversity in science, for instance, by recruiting and retaining practitioners from underrepresented social groups, providing incentives for explorative and risky research, encouraging interdisciplinary collaborations and stakeholder participation in research, requiring industry scientists to share their evidence, and developing strategies to encounter politically motivated attempts to manufacture doubt. To be successful, efforts to promote diversity in science should anticipate risks related to institutional interventions, navigate trade-offs between different types of epistemically good outcomes, and identify hidden costs that such policies may cause for various actors. Such efforts need to be assessed not only from an epistemic perspective but also from the point of view of fairness and the political legitimacy of scientific institutions.

More diverse research groups and scientific communities are claimed to have an epistemic advantage over less diverse ones, if not always, at least under certain conditions – for instance, when group members uphold certain epistemic standards and are committed to open, respectful, and responsive discussion. Philosophers of science argue that diversity contributes to scientific progress because it generates and maintains a fruitful distribution of research efforts (Kitcher 1990; Solomon 1992), ensures the availability of a variety of cognitive resources (Grim et al. 2019; Reijula & Kuorikoski 2021), and helps scientists eliminate or minimize the effects of biases (Longino 1990). In epistemically well-functioning scientific communities, diversity gives rise to critical exchanges which promote the objectivity of scientific knowledge (Longino 2002). Diversity is also thought to be a source of scientific creativity and renewal by leading scientists to pose new research questions, propose new solutions to complex research problems, search for new types of evidence, develop new methods of inquiry, and propose new hypotheses and theories (Solomon 2001; Wylie 2003). In addition to having epistemically beneficial outcomes, increased diversity is thought to promote equity and fairness especially when it means that members of underrepresented social groups participate in the production of scientific knowledge to a larger extent than they have done thus far (Intemann 2009).

The Topical Collection on *Social and Cognitive Diversity in Science* focuses on the epistemic significance of diversity. As the contributions to the topical collection illustrate, social epistemological inquiries into diversity are interested in its many dimensions, ranging from cognitive to demographic and social value diversity. A group is *cognitively diverse* when its members differ, for example, with respect to their disciplinary background, expertise and skills, problem-solving heuristics, or strategy each group member uses to explore a common field of research.[1] A group is *demographically diverse* when its members occupy different social locations (e.g., with respect to gender, class, ethnic identity, nationality, and race). A group has *social value diversity* when its members endorse different social and political values, or act as representatives of different interest groups. While demographic diversity sometimes generates cognitive and social value diversity, it does not do so automatically, and hence, it is important to consider each of the three dimensions of diversity as distinct from others.

Feminist philosophy of science calls attention to the lack of demographic diversity in science and its impact on the content of scientific research as well as the social practices of science (see e.g., Crasnow & Intemann 2021). For example, feminist standpoint empiricists argue that demographic diversity with respect to those social locations that track systemic relations of power or other types of being privileged or unprivileged is of epistemic interest. This type of diversity has the potential to create epistemically productive cognitive diversity, either diversity of social experiences relevant to scientific inquiry (Crasnow 2014; Intemann 2010; Wylie 2003), or diversity of value-laden perspectives on the subject matter of inquiry (Anderson 2004; Longino 1990). More recently, Steel et al. (2021) argue that demographic diversity can improve group performance even when it does not give rise to cognitive or social value diversity. This is because it is likely to generate an expectation of cognitive diversity among group members, and mere expectation gives them a reason to process task-related information more carefully and spend more time communicating their views to others (see also Loyd et al. 2013; Phillips 2014).

[1] For an extensive overview of empirical research on cognitive diversity, and an account of the mechanisms that link cognitive diversity to collective intelligence, see Sulik, Bahrami & Deroy (2022).

Acknowledging that cognitive, demographic and social value diversity, either separately or jointly, can be epistemically beneficial, philosophers ask what scientific institutions can do to promote diversity and its epistemically advantageous outcomes. Some philosophers recommend that institutions promote diversity of perspectives by recruiting and retaining practitioners from previously excluded or marginalized social groups (Longino 1990, 2002; Wylie 2003); some others emphasize the importance of having incentives and other institutional arrangements that promote explorative and risky research (Avin 2019; Heesen & Romeijn 2019; Kitcher 1993). While philosophers see diversity as an epistemic resource, they also recognize that there are limits beyond which increased diversity may longer benefit science epistemically. For example, cognitive diversity is helpful when the research problem at hand is sufficiently complex and difficult, but relatively simple problems can be solved without much diversity (Pöyhönen 2017). And when there are compelling reasons to arrive at a consensus on a theory or a hypothesis, diversity of views can even be epistemically harmful if it means that resources are wasted on wrong theories. Some philosophers have pointed out that the epistemic goal for the social organization of science cannot be diversity per se, but transient diversity (Zollman 2010).

While many philosophers believe that scientific institutions should do more to promote diversity than they have done so far, some philosophers call attention to costs, risks, and trade-offs involved in efforts to increase diversity for the sake of its epistemic potential (e.g., Fehr 2011; Peters 2021). For example, Fehr (2011) emphasizes the costs of developing novel perspectives and the risks faced by those individuals who aim to do so. Increased demographic diversity may not generate epistemically fruitful cognitive diversity without systematic support from scientific communities and institutions.[2] Developing a novel perspective by drawing on one's social location as an epistemic resource (for instance, one's social experiences, information from one's networks, or data from research participants), requires "epistemic diversity work" (Fehr 2011, 141). Unfortunately, such work is often unrecognized and undercompensated professionally. To make things worse, practitioners engaged in epistemic diversity work may have to pay a "novelty tax" (Fehr & Jones 2022, 12). This extra cost arises because it is more labor-intensive to develop and justify a novel approach than to work in a well-established research program. As Kuhn (1996) recognized, this explains in part why scientific communities tend to converge towards normal science, that is, problem-solving within a given paradigm. Cognitive homogeneity creates many kinds of efficiencies of its own. Thus, one thing scientific communities and institutions can do is to recognize and reward epistemic diversity work and provide publication venues for non-mainstream work.

In addition to the cost of epistemic diversity work, philosophers identify other types of costs and risks that can arise when institutions attempt to promote diversity in science. For example, cognitive diversity can increase the costs of communication across the boundaries of disciplines or specialties (MacLeod 2018) and the risk of polarization, a situation where subgroups continue to hold opposing views (O'Connor & Weatherall 2018). Moreover, industrial and political interest groups may take advantage of cognitive diversity in their attempts to fabricate doubt and create the image that scientific communities have not reached a well-grounded and sufficiently wide consensus on certain issues (Biddle & Leuschner 2015; de Melo-Martín & Intemann 2018; Holman & Bruner 2017). Thus, institutional interventions intended to increase cognitive diversity in science may fail or lead

[2] A central finding in the empirical literature on cognitive diversity is that collecting the epistemic benefits of diversity - the diversity bonus - and overcoming difficulties requires careful management of group dynamics and practices (Mannix & Neale 2005).

to unintended and undesired outcomes if institutions do not compensate for extra costs of pursuing novel and risky lines of research, or if they do not take into account the risk of manufactured doubt and design a plan for minimizing its harms.

As the call for increased demographic diversity in science is often defended on moral and legal grounds (e.g., equal opportunity, anti-discrimination), philosophers have become increasingly concerned about tensions between moral/legal and epistemic arguments for increasing diversity. For example, there is a trade-off between social justice concerns and the epistemic benefits of diversity when the latter are contingent on social identity stereotypes which are harmful for those who are subjected to the stereotypes. Such a trade-off underlies the argument that demographically heterogeneous groups are less likely to succumb to epistemic conformity than homogeneous ones because demographic diversity tends to decrease trust among group members (Steel & Bolduc 2020). If this is the case, then the epistemic benefits of diversity depend on unfair social background conditions where a testifier's credibility is diminished because of a hearer's social identity prejudice against the testifier. As Steel and Bolduc argue, "epistemic conformity along the lines of social identity is very plausibly categorized as an epistemic injustice" (2020, 432). Despite these concerns, efforts to promote fair treatment of practitioners and reap the epistemic benefits of diversity often go together. For example, critical exchanges generated by cognitive and social value diversity are more likely to improve scientific research when community members enjoy equality of intellectual authority (even if it is tempered) than otherwise (Longino 2002).

Each of the contributions to the Topical Collection on *Social and Cognitive Diversity in Science* examines these issues and questions further.

Reijula, Kuorikoski and MacLeod (2023) introduce a novel approach to modeling the division of cognitive labor in science. Instead of aiming to understand how a scientific community should distribute research efforts to solve a single problem efficiently (e.g., Kitcher 1990), they model a division of tasks into a set of subtasks. Division of cognitive labor in the latter sense requires the allocation of subtasks to different problem solvers and the adoption of a strategy for combining subtask solutions to answer the overall question of the collaboration. Their modeling framework allows one to represent problems with various degrees of complexity where complexity depends on the extent to which subtask solutions are dependent on each other. Most importantly, the modeling framework allows one to examine trade-offs between fast modular approaches to problem-solving and slow holistic ones. Reijula, Kuorikoski and MacLeod apply this framework to multi- and interdisciplinary collaborations. The expected epistemic benefit from such collaborations consists of practical solutions to complex environmental, social and technological problems which no single discipline can solve on its own. Besides epistemic benefits, Reijula, Kuorikoski and MacLeod are interested in the opportunity costs that such collaborations involve. The time and energy scientists spend on multi- and interdisciplinary collaborations could also be used to produce solid disciplinary results. Thus, the challenge is to understand when the costs outweigh the benefits so that pursuing multi- or interdisciplinary collaboration is no longer worth the effort. Reijula, Kuorikoski and MacLeod are critical of the current funding model that favors short-term multi- and interdisciplinary projects. In their view, such projects are unlikely to find optimal solutions to complex problems and can lead to methodological conservatism. An alternative to this funding model would be a long-term institutional commitment to support multi- and interdisciplinary collaborations.

Wu and O'Connor (2023) ask what are the best ways to maintain an appropriate amount of cognitive diversity in scientific communities. They explore other ways to cultivate cognitive diversity in addition to two of the most obvious ways: increasing demographic diversity and promoting work by epistemically marginalized scholars and scientists.

Scientific institutions such as funding agencies can maintain cognitive diversity by supporting exploratory or risky research. Institutions can also increase cognitive diversity by requiring or incentivizing industries to share their research results, if not immediately, at least after a set period. More generally, Wu and O'Connor (2023) emphasize that if philosophers of science wish to make recommendations based on modeling studies, they should pay close attention to ethical and practical constraints posed by real epistemic communities. In their view, several mechanisms for maintaining transient diversity are not particularly promising avenues for interventions because they are either impractical or unethical to implement. This is the case, for example, for Zollman's (2010) well-known but also criticized study (see e.g., Rosenstock et al. 2017). Zollman aims to show that a scientific community may end up with an epistemically inferior theory if they converge on a consensus view too swiftly and do not spend enough time to explore alternative theories. He suggests that better results could be achieved if the flow of information were delayed in scientific communities to guarantee enough exploration. Yet, it is not clear what measures scientific institutions could use to do so.

Fernández Pinto and Fernández Pinto (2023) discuss the question of whether industry funded research can increase epistemically beneficial diversity of scientific practices. They argue that even if industry is required to share research results, these results may not add to epistemically beneficial diversity in science. Sometimes industry funded research introduces biased results rather than helps scientists identify and eliminate the effects of biases. Industrial selection bias is one mechanism that helps understand how industry can shape the results of scientific research without directly influencing the methodological decisions of any individual scientist (Holman & Bruner 2017). The mechanism is that industry can select and fund those scientists who already have industry-friendly views. Fernández Pinto and Fernández Pinto explore the industrial selection bias by introducing a reinforcement learning model which simulates the process of industrial decision-making when allocating funding to scientific projects. In their model, the industry learns about the success rate of individual scientists and updates the information they use to make decisions on each round. Fernández Pinto and Fernández Pinto agree with Holman and Bruner (2017) that the more cognitively diverse the scientific community, the easier it is for the industry to challenge a scientific consensus. However, their remedy to the problem is different from the one proposed by Holman and Bruner. Fernández Pinto and Fernández Pinto consider the random allocation of funding for research projects as one possible strategy to counteract industrial selection bias.

While many philosophers propose institutional solutions for maintaining an appropriate amount of cognitive diversity in science, Koskinen (2022) is less optimistic about the effectiveness of such actions. Institutional interventions are typically top-down measures implemented by means of regulations or incentives such as research funding instruments, and as such they differ from scientists' spontaneous attempts to renew science. Koskinen discusses several examples of such interventions, focusing on attempts to increase social value diversity in science by involving citizens or stakeholders in research and attempts to increase cognitive diversity in science by encouraging multi- and interdisciplinary collaborations. In the former cases, institutional initiatives run the risk of alienating those social groups who do not agree on the rules of participation, or the consensus-seeking aims of deliberative processes. They also run the risk that some powerful stakeholders seize the process of deliberation and (mis)use it for their own purposes. In the latter cases, top-down attempts to create multi- and interdisciplinary collaborations may fail to generate desired cognitive diversity when the collaboration is merely a convenient umbrella for separate research projects, or a cover-up for one disciplinary subgroup's domination over others. As Koskinen (2022) argues, institutional interventions often fail to achieve their goals because institutions lack means to control complex social processes. However, top-down implemented institutional solutions are not the only way to increase diversity in science. For example, scientific/intellectual movements where researchers collaborate with social movements active in a larger society can be successful in generating cognitive or social value diversity in science (Koskinen & Rolin 2019).

Like Koskinen, Schroeder (2022) discusses attempts to increase cognitive and social value diversity in science by citizen science and other participatory research projects. He compares them to efforts to enhance cognitive and social value diversity by increasing the numbers of women in those areas of science where women are still underrepresented. He argues that in each case, diversifying science can improve the quality of scientific results in three distinct ways: epistemically, ethically, and politically. However, it is not always the case that these three dimensions go hand-in-hand. All these three dimensions may come apart. For example, what seems to be beneficial epistemically, is not necessarily acceptable from a moral or political point of view. Also, what is right from a substantive ethical perspective can lack political legitimation, and what is politically legitimate can be wrong from a substantive ethical perspective. Schroeder argues that the mechanisms mediating between diversity and its benefits are different in each case, especially when it comes to understanding political arguments in favor of demographic and social value diversity. In the case of increasing citizens' participation in scientific research projects or science policy decisions, the aim is to give political legitimation to non-epistemic values that guide research agendas and processes. In the case of increasing women's participation in science, the route to political legitimation is different. Increasing women's numbers in science is believed to strengthen the political legitimacy of science by purging scientific research from non-epistemic values that are, by their nature, politically illegitimate (e.g., anti-egalitarian values). According to Schroeder, this means that institutional efforts to recruit and retain women in science do not need to be concerned with the difference between epistemic, ethical, and political improvements. In his view, they are not generally in conflict with one another and can typically be realized at the same time. However, in citizen science and other participatory research projects, scientists will have to navigate trade-offs between epistemic, ethical, and political improvements.

Steel and Paier (2022) are less optimistic about attempts to align moral and political arguments for increased demographic diversity in science with epistemic ones. They argue that despite good intentions, institutional efforts to promote demographic diversity in science can give rise to the diverse person's burden, an unfair expectation for members of underrepresented social groups to produce distinctive epistemic bonuses associated with their social identity (see also Fehr 2011, 142; Steel & Bolduc 2020, 434). The expectation is unfair because other social groups are not expected to justify their presence in scientific communities by producing epistemically unique perspectives. To explain how the diverse person's burden arises, Steel and Paier (2022) discuss the phenomenon of psychological entitlement. Psychological entitlement means the tendency of privileged individuals to believe that inequalities that benefit them are fair because such inequalities can be attributed to differences in merits. As Steel and Paier argue, "The belief that selection by individual merit explains homogeneity while diversity is sought because of its potential to produce bonuses suggests that diverse people should go above and beyond to prove they belong" (2022, 357). They also propose structural, institutional, and individual remedies to the diverse person's burden.

Leuschner and Fernández Pinto (2022) examine limits to the benefits of cognitive diversity in science. Sometimes cognitive diversity leads to scientific dissent, that is, disagreement that challenges an otherwise widely accepted scientific view. Leuschner and Fernández Pinto analyze dissenting studies that question the shooting bias hypothesis, the claim that racial biases among police officers are a significant factor in fatal shootings. While they do not question the sincerity of dissenting scholars, they argue that their studies make questionable generalizations and present results in a way that makes it easy for the media to misuse them. Had the dissenting scholars attended to the political and social consequences of error more carefully, they would have been more cautious when they interpreted their data and communicated their findings.

Philosophical research on the epistemic significance of diversity has also breathed new life into old questions about the methods of philosophy of science. While much research on diversity relies on case study methods (Crasnow 2021), philosophers of science also explore computer simulation methods and adopt modeling frameworks from other sciences (O'Connor 2020; Reijula & Kuorikoski 2019; Aydinonat et al. 2021; Šešelja 2022). In their attempts to understand how demographic diversity gives rise to cognitive or social value diversity, and how each type of diversity can lead to epistemically valuable outcomes, philosophers draw on empirical research in various fields, ranging from organization studies to social psychology. In this topical collection, Pesonen (2022) argues that cognitive psychology and especially the argumentative theory of reasoning (Mercier & Sperber 2011) is a promising resource to diversity studies. The theory highlights the benefits of reasoning in a collaborative and interactive setting as against reasoning in isolation, and thereby helps understand how diverse groups can overcome biases that are difficult for individuals to detect on their own. Yet merely few social epistemological studies have paid attention to what Pesonen calls the social processing of information, reasoning carried out in a collaborative and interactive setting. Thus far many diversity studies have focused on the processing of social information (e.g., Fazelpour & Steel 2022; Steel et al. 2021) and the distributed processing of information (e.g., Hong & Page 2004). Whereas the social processing of information calls attention to argumentative interactions among group members from the perspective of cognitive psychology, the processing of social information focuses on how group members respond to other group members' social identities and the distributed processing of information on the division of cognitive labor and mere exchange of information among agents.

To summarize, diversity (demographic, cognitive or social value) is believed to be an epistemically desirable feature of research groups and scientific communities. Yet, efforts to maintain an appropriate amount of cognitive diversity or increase demographic or social value diversity in science may fail or lead to unintended and undesired outcomes if scientific communities and institutions are not aware of costs, risks, and trade-offs between various epistemic benefits and other good outcomes. The contributions to the Topical Collection examine how scientific communities and institutions can avoid such pitfalls. To be effective, policies aiming to encourage multi- and interdisciplinary collaborations should recognize opportunity costs involved in such collaborations. When scientific communities succeed in maintaining a certain amount of cognitive and social value diversity, they should be aware of the risk of industrial selection bias and epistemically harmful dissent. Policies aiming to promote demographic diversity in science should involve remedies to address the diverse person's burden. More generally, attempts to promote demographic diversity for the sake of its epistemic advantages should be evaluated from an ethical point of view as well as from the perspective of political legitimacy. For example, when feminist philosophers highlight the epistemic benefit of developing perspectives of marginalized social groups, they do not thereby suggest that marginalization is to be maintained because of epistemic benefits. The underlying assumption is rather that developing such perspectives is valuable not so much for the sake of knowledge itself but rather because this type of knowledge can serve social justice and strengthen the political legitimacy of scientific institutions.

The Topical Collection on *Social and Cognitive Diversity in Science* provides an up-to-date critical assessment of research on the epistemic significance of diversity in science. It proposes ways to move toward an empirically and theoretically more accurate understanding of diversity and its epistemic effects as well as a better account of how epistemic aspects of diversity interact with moral, legal and political ones.

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