What Role Does Diversity Play in Successful Science?

The German scientific community is debating the very core of science – and why diversity is an integral part of it.

By Londa Schiebinger, John L. Hinds Professor of the History of Science at Stanford University

Diverse teams aren't a burden to good science. Well-run research teams enhance modern scientific investigations. Under the right conditions, teams may benefit from various types of diversity, including scientific discipline, work experience, gender, ethnicity, and nationality. Experimental research has found that the "collective intelligence" of diverse groups is greater than the sum of the individual IQs of their members.

But "diversity in" does not automatically lead to "creativity out." Careful management (as shown in the figure below) is required to maximize the benefits of diversity. These techniques include: creating a positive climate, utilizing team expertise, diversifying research methods, establishing non-hierarchical structures, etc.

Nielsen, M. W., Alegria, S., Börjeson, L., Etzkowitz, H., Falk-Krzesinski, H. J., Joshi, A., Leahey, E., Smith-Doerr, L., Woolley, A.W., & Schiebinger, L. (2017). Gender diversity leads to better science. *Proceedings of the National Academy of Sciences*, *114*(8), 1740-1742.

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Questions asked by Christine Vallbracht, editor for **Forschung & Lehre**

Gender diversity may also spark new discoveries by broadening the viewpoints and questions asked by researchers. Our research shows that there are three key types of diversity: teams (participants in the room), methods (including gender and sex analysis (GSA), and, perhaps most importantly, questions asked.

	Teams	Methods	Questions
Focus	Gender composition of research teams	Integration of GSA into research design	Changes in research questions and priorities
Evaluation	Assess the numbers of citations, publications, patents, and so on	Analyse the proportion and quality of GSA in funding proposals and publications	Map large-scale patterns in the topics addressed and questions raised in research
Future research	How does team diversity contribute to the social impact of research?	What is the value of GSA to society in terms of human well-being and economic impact?	Will increasing the numbers of women change research questions, or will changing questions increase the numbers of women in research?

Nielsen, M. W., Bloch, C. W., & Schiebinger, L. (2018). Making gender diversity work for scientific discovery and innovation. *Nature human behaviour*, *2*(10), 726-734.

We also found that when new participants enter traditional disciplines, such as History (my own), new questions were asked. Our diachronic analysis of US history dissertations from 1980 (when online data is first available) to 2015 and a select set of general history journals from 1950 to 2015 revealed this correlation between author gender and research agendas over time. While there was significant overlap between men and women's historical interests, in some cases, we see that the new participants (in this case women) expanded topics and developed new subfields in the discipline. For example, primarily women developed women and gender history, history of the body, history of consumption and consumerism, among other topics. But men and women equally addressed topics such as historiography, history of Africa, and organizations.

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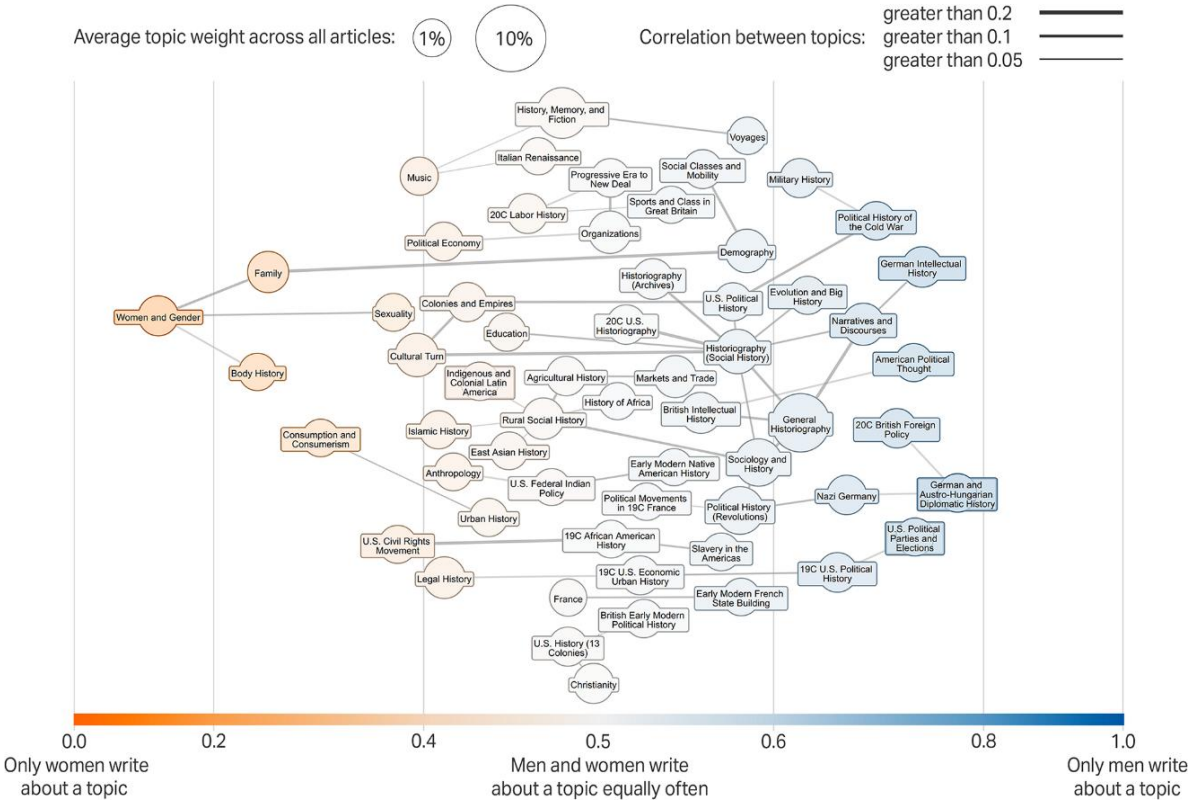

Risi, S., Nielsen, M. W., Kerr, E., Brady, E., Kim, L., McFarland, D. A., Jurafsky, D., Zou, J., & Schiebinger, L. (2022). Diversifying history: A large-scale analysis of changes in researcher demographics and scholarly agendas. *PLoS One*, *17*(1), e0262027.

To what extent has diversity already contributed to success in science?

Integrating sex and gender analysis into the design of research, where relevant, can lead to discovery and improved research methodology. A deeper understanding of the genetic and hormone-mediated basis for sex differences in immunity, for example, promises insights into novel cancer immunotherapies. Evidence that facial recognition systems misclassify gender more often for darker-skinned women than for lighter-skinned men has led to refinements in computer vision. Understanding sex-based responses to climate change allows better modeling of demographic change among marine organisms and the downstream effects for humans. Sex and/or gender analysis can be critical to the interpretation, validation, reproducibility, and generalizability of research findings.

The “where relevant” is important here. Black holes, for example, have no sex or gender. No one would ask for this type of analysis in the content of theoretical

physics or pure mathematics. When it comes, however, to AI, basic technologies, human society, planetary health, marine science, and much else, sex or gender analysis can be important.
We could multiply examples here of where sex and/or gender analysis leads to new insights in facial recognition used in autonomous vehicles or by international border technologies, heart disease in women, osteoporosis disease in men, stem cell research, marine protected areas for sea turtles, prescription drugs, microplastics research, to name a few.

There is much more to say here. For the interested, I suggest: Tannenbaum, C., Ellis, R. P., Eyssel, F., Zou, J., & Schiebinger, L. (2019). Sex and gender analysis improves science and engineering. *Nature*, *575*(7781), 137-146.

What is the connection between intersectionality and diversity?

Intersectionality is a more sophisticated term for diversity. Intersectionality describes how sex, gender, family configuration, education, age, and other socio-political dimensions interact to shape people's experiences of privilege and discrimination, empowerment or marginalization. By focusing on the compounded effects of social categories, intersectional analysis can enhance the accuracy and experimental efficiency of science and technology.

There are several interesting tools for intersectional research. In 2021, Gendered Innovations produced our Intersectional Design Cards for inclusive products, processes, and paradigms—specifically for industry. We emphasized twelve intersectional factors, including age, disabilities, educational background, ethnicity, family configuration, gender, geographic location, race, sex, sexuality, social and economic status, and sustainability. About the same time, Apple released its Intersections of Diverse Axes to empower and delight everyone, which included class, culture, ethnicity, language, education, political beliefs, philosophical beliefs, religion, race, gender, sexual orientation, age, abilities, disabilities, handedness, body measurements, environment, location, connectivity, modern technology. Handedness here is interesting—and one my team had not considered. For example, my neighbor on the Stanford campus is a world renown surgeon, but she is left-handed. Most surgical instruments are made for right-handers. Think of how much more distinguished she could be if the technology had met her needs rather than her needing to meet the technology's needs.

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However interesting these lists of intersectional factors may be, the first point to make is that factors differ by culture. Both sets of factors here were developed in a US context. In Germany, for example, one would not ask about race, as understood in the US. But because researchers often design for a global culture, they may still need to consider factors such as skin tone and cultural background. A second point to make is that each researcher needs to choose the factors most relevant to their project or product. A research team cannot look at all the factors—so, as with any research project, researchers need to choose what to focus on. But this decision should not rely on an unconscious default.

Our recent *Nature* article extends intersectional approaches, developed for the most part in the humanities, social sciences and public health, to the fields of natural science and technology, where this type of analysis is less established (Box 1). We extracted methods to demonstrate how quantitative intersectional analysis functions throughout the research process, from strategic considerations for establishing research priorities to formulating research questions, collecting, and analyzing data, and interpreting results. We also offered a set of guidelines for researchers, peer-reviewed journals, and funding agencies that facilitate systematic integration of intersectional analysis into relevant domains of science and technology.

Box 1: Intersectional factors may be considered at three levels of analysis

Socio-political dimensions refer to the social categories, identity variables and positions of advantage and disadvantage, such as sex, gender, ethnicity, sexual orientation, geographic location, class, caste, religion, etc. that may be central to intersectional analysis. “Dimensions” captures the idea that each category may include multiple sub-variables.

Contextual domains refer to large social systems, such as legal, healthcare or criminal justice systems, state or global policies, educational institutions and religious bodies, that contribute to social advantages or disadvantages at the socio-political level. These domains may shape individual life choices and opportunities, and should be considered in any intersectional endeavour.

Environmental conditions refer to local and global dynamics related to air-, soil- and water quality, for example. Capturing relationships of privilege and disadvantage in the domain of environmental conditions requires attention to community-level variations to identify who is at risk from environmental hazards and climate-related disasters, and who is most likely protected and resilient.

Nielsen, M. W., Gissi, E., Heidari, S., Horton, R., Nadeau, K. C., Ngila, D., Noble, S.U., Paik, H.Y., Tadesse, G.A., Zeng, E.Y. and Zou, J., & Schiebinger, L. (2025). Intersectional analysis for science and technology. *Nature*, *640*(8058), 329-337.

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What is the strongest argument for greater diversity in science?

Ignoring sex and gender analysis can lead to inaccuracies, research inefficiency, and difficulties generalizing results. At the same time, integrating sex, gender, and/or intersectional analysis into science can lead to discovery and innovation. See the Gendered Innovations in Science, Health & Medicine, Engineering, and Environment website where we give 40-some specific examples.

What would you say if someone described gender studies as an ideology without empirical evidence?

I would emphasize the empirical evidence that sex can be an important biological variable in research. Let's take automobile safety. In US automotive crashes, belt-restrained women are 47% more likely than belt-restrained men to be injured – after controlling for weight and body mass. If we drill down, we see that risk of injuries for female vs male drivers or front row passengers of similar age are: injuries to the head are 22.1% higher for females, to the neck, 44.7% higher, to the chest 26.4% higher, to the abdomen 38.5% higher. This is because analyzing sex is missing in: 1) female geometry, such as the shape and form of the torso; 2) female muscle and ligament strength; 3) female spinal alignment; 4) female dynamic responses to trauma; and 5) mass distribution of different body parts. These risks are real – nothing ideological about them. Recognizing these dangers led Swedish engineer, Astrid Linder, to create one of the first 50th percentile female crash test dummies – EvaRID (Rear Impact Dummy).

Analyzing gender has led to the recognition of a long-standing ideological failure of automobile safety testing: A small 5th percentile female dummy has traditionally been placed in the passenger seat of the car – as if women don't drive. The assumption that women are passengers as opposed to drivers is a gendered norm that has limited understanding of how the steering wheel interacts with the female body. Intersectional variables might include elderly or obese drivers, where we may find differences between fragility and fatality risk in female and male bodies. And, if we analyze sex in research priorities, we see the need for innovation in seatbelt safety for pregnant women to protect vulnerable fetuses.

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Analyzing gender as a socio-cultural variable and, more broadly, intersectionality can be equally important. Consider social or domestic robots – for sure, the robots are coming! – and how they might be gendered. Anthropomorphizing technologies may help users to engage more effectively with them, which poses the question: are there benefits to tapping into the power of social stereotypes by building gender into virtual agents, chatbots, or social robots?

For example, if roboticists deploy female care robots in female-typical roles, such as nursing, would users better comply with the robot's requests to take daily medication or do prescribed exercise? Does gendering robots or virtual agents facilitate interaction or boost objective outcomes, such as performance? Will personalizing robots or chatbots by gender increase consumer acceptance and, even, sales figures? Systematic empirical research will be key here. Building hardware to stereotypes may enhance social acceptance but doing so may also harden and perpetuate these same stereotypes. Nursing, for example, is currently a good profession. Only ~11% of nurses globally are men – does building nursing robots toward stereotypes further exclude men from this domain?

Whether pursuing research in aerospace, agriculture, or haptic technologies, harnessing the creative power of sex, gender, and intersectional analysis may add valuable dimensions to research or take research in new directions. The goal of this type of analysis is to advance health, prosperity, discovery, and innovation. As readers will recognize, these methods are one set among many that researchers will deploy to help achieve these goals.

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