Authors Without Borders: Guidelines for Discussing Authorship with Collaborators

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Sigma Xi, The Scientific Research Honor Society

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About Sigma Xi

Sigma Xi, The Scientific Research Honor Society, is the international honor society of science and engineering. One of the oldest and largest scientific organizations in the world, Sigma Xi has a distinguished history of service to science and society for more than one hundred and twenty-five years. Scientists and engineers, whose research spans the disciplines of science and technology, comprise the membership of the Society. Sigma Xi chapters can be found at colleges and universities, government laboratories, and industry research centers around the world. More than 200 Nobel Prize winners have been members.

Dedication

We dedicate this to our colleague and friend, Dan Vasgird. Dan’s fierce intellect, commitment to integrity, and abiding compassion informed most every stage of this project and are evident throughout. This work, as well as the lives of his colleagues and friends, are the richer for his presence in them.

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Preface

Sigma Xi, The Scientific Research Honor Society, was established in 1886 with the mission of promoting and recognizing excellence in scientific research and advancing interdisciplinary collaborations. Over the years, Sigma Xi has significantly contributed to the scientific community through its support for researchers and by promoting ethical and responsible conduct of research. In addition to this current volume, Sigma Xi has published three works to highlight and encourage ethical research practices. Each of these publications is rooted in Sigma Xi's commitment to fostering ethical conduct in research and has played a role in guiding the scientific community to develop and maintain professional standards for conducting research.

The Society's commitment to promoting ethical standards in research was first demonstrated in *Honor in Science* (Sigma Xi, 1984), which remains a quintessential guide to ethics and values in research. This influential work, in its seventh printing in 2000, is one of the first collections that offered practical advice to early career researchers when facing moral dilemmas. In 1999, Sigma Xi published *The Responsible Researcher: Paths and Pitfalls* (Ahearne, 1999) to discuss ethical considerations relevant to a broader audience, from undergraduate students to deans and chairs, industry, government, and non-governmental organizations. This work effectively underscores the significance of responsible conduct in scientific endeavors at all career stages and settings within and beyond academia. Released in 2011, *For the Record: American Scientist Essays on Scientific Publication* (Sigma Xi, 2011) is a compilation of expert insights exploring ethical challenges related to publication including authorship and peer review. These insights shed light on complexities associated with authorship and touch on specific trends such as digitization, and internationalization of scientific collaborations. Building on these previous publications, the current volume aims to delve deeper into authorship issues. It identifies common sources of misunderstandings that can lead to conflicts within collaborations and promotes proactive and culturally sensitive discussions on co-authorship.

Origins of the Authors Without Borders project

Given the increasingly international and interdisciplinary nature of science and engineering, researchers need practical information about variations in authorship practices. This information will assist researchers in recognizing factors that can contribute to miscommunication and misunderstanding among collaborators as

well as increased awareness of strategies that foster clear communication and transparency (Heitman, 2014). Moreover, domestic research groups can also be quite diverse and international, and often include postdoctoral trainees and graduate students with multinational education and research experience. The Authors Without Borders project was undertaken to both explore authorship practices, and to develop guidelines for discussion to assist researchers in effectively navigating authorship decision-making in collaborative domestic and international research projects.

Toward that end, the project consisted of two phases. In the first phase, we conducted 25 peer discussion groups with postdoctoral trainees and senior researchers, separately and together, focusing on their experiences with authorship including perceptions of, and responsibilities related to, authorship, and authorship issues they had encountered. Group discussions were followed by phone interviews with participants in order to clarify and expand on their responses in the original discussion. These peer discussion groups took place in the US, China, Brazil and Germany (approximately six groups in each country) with participants from the two disciplines of neuroscience/psychology and engineering (both broadly defined). The total number of participants was 125 (with slightly fewer follow-up interviews). Of these, 72 were in neuroscience/psychology (33 postdocs and 39 faculty; approximately 50 percent women), and 53 in engineering and the physical sciences (approximately one-third women). The purpose of these discussions and the follow-up interviews was to facilitate creation of an in-depth survey of the kinds of issues and obstacles researchers encounter in international collaborations. In the process, we gained context-specific knowledge that further complemented what is already known about authorship issues and collaborative research in general.

In the second phase, we developed a survey to identify the full range of questions, issues, and concerns that arise among collaborators in association with authorship[1]. The resulting survey was translated as appropriate and distributed primarily through Sigma Xi chapters and/or member researchers in various disciplines in 91 countries. This was primarily a qualitative rather than a quantitative study. As a result, *Authors Without Borders* does not present

[1] This two-step process – discussion groups and individual interviews to inform survey development – had been successfully used by Michael Kalichman and Dena Plemmons in a National Institutes of Health-funded project in the United States which looked at standards for authorship, among other practices, across four disciplines (Kalichman et al., 2014; Kalichman et al., 2015).

statistical findings but instead, includes pertinent quotations from the survey and the peer discussion groups.

It is important to note that our goal was not to identify the most common issues, or the frequency of authorship irregularities. Rather, we wanted to uncover the wide array of concerns, including those that may rarely be spoken of, or even be apparent, until the final, publication stage of a project. More specifically, we wanted to identify, and then facilitate and promote discussion of, issues that reflect differences in assumptions or expectations (even uncommon ones) that can lead to (or arise from) miscommunication or misunderstandings. Indeed, it was an explicit goal of this project to develop guidelines *for discussing* authorship, *not* guidelines for authorship itself.

Authors Without Borders uses the data collected throughout the project, as well as more recent publications that have examined similar issues. In so doing, *Authors Without Borders* intends to (i) enhance awareness of ethical issues associated with authorship that researchers might face in collaborative projects, (ii) assist in the identification of frequent sources of misunderstanding associated with authorship that can result in conflicts, and (iii) contribute to the development of guidelines for discussion that can serve as a basis for proactive, ethical and culturally sensitive conversations about co-authorship. *Authors Without Borders* also lays the foundation for future research and education aimed at building researchers' capacity to discuss authorship, most especially in international and multidisciplinary collaborations.

The work presented herein has been supported by two grants from the National Science Foundation (NSF), awarded to Sigma Xi. The first grant was entitled "Authors Without Borders: Investigation of International Authorship Norms among Scientists and Engineers" (#**1338449**), and the second was entitled "Authors Without Borders: Continuing Investigation of International Authorship Norms among Scientists and Engineers" (#1**835237**) under the stewardship of Dena K. Plemmons (University of California, Riverside), Stephanie J. Bird and Daniel Vasgird. Mohammad Hosseini (Northwestern University) joined in the latter stages of the project, collaborating on data synthesis and writing.

The authors of this publication are listed alphabetically.

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We want to specifically acknowledge our late colleague and co-Principal Investigator on this project, Dr. Daniel Vasgird, without whom this project would simply not have been possible.

Many people have been involved with this project over its 10 years. We would like to thank 1) our advisory group members, including: Melissa Anderson, Jason Borenstein, Vanessa Campo-Ruiz, Mark Frankel, Michele Garfinkel, Michael Kalichman, Rudiger Klein, Adil Shamoo, and Sonia Vasconcelos; 2) our Peer Discussion Group Leaders: Youqing Wang and Xinwen Bai, China; Renato Rozental and Renan Moritz, Brazil; Astrid Schütz and Alexander Mitsos, Germany; and Peer Discussion Assistants, including: Karina de Albuquerque Rocha and Deborah Montiero Moretti, Brazil; Katrina Burkel, Germany; Elizabeth McCarthy, US; 3) the researchers who helped with the translation of our surveys; 4) our exceptional guidance and support from Sigma Xi: Jerome Baker, Jamie Vernon, Jasmine Shah, Eman Ghanem, Michelle Taber, Katie Burke and Elsa Youngstedt, Diane Ballard, and many others throughout the tenure of this project; 5) our ongoing and essential support from the University of California, Riverside: Kyla Rankin, for support with survey dissemination and general project management, and Gwendolyn Gardiner and Daniel Lee for statistical analyses; and invaluable encouragement and logistical support from colleagues Michael Baum at Boston University, and Clyde Briant at Brown University; 6) the thoughtful survey beta testers who were so helpful in finalizing the survey, including Iris Bahar, Amy Banzaert, Rod Beresford, Debbie Chachra, Joseph Crisco, Michael Loui, and Nitin Padture; and 7) external readers who provided invaluable feedback on our penultimate draft: Daniel Carey, Marlyn Faure, Catherine Fiore, Michele Jacob, Heidi Matisonn, Elizabeth McCarthy, David Resnik, and David Weaver.

Finally, we owe a debt of gratitude to our Peer Discussion Group participants as well as the more than 2000 respondents who took the final survey.

1. Introduction

Authors Without Borders explores the intersection of two complex issues in science and engineering, namely the issues of international and interdisciplinary collaborations, and authorship of peer-reviewed publications. A focused examination of these issues is relevant, topical, and urgent; as collaborative research evolves, it blurs cultural, national, and disciplinary borders (National Science Board, 2022). With the increasing incidence of, and opportunities for, cross-border collaborations come new challenges and complex ethical issues, some of which are related to authorship of peer-reviewed publications.

In scientific projects, authorship matters because when collaborators are listed as co-authors, it is assumed by the readers that they have been involved in specific and meaningful ways in the work that led to publication, and therefore, deserve to be particularly recognized as authors. Simultaneously, by means of authorship, researchers are recognized for their contributions, and the community can identify those responsible for the veracity and reliability of the claims presented in a publication. In this sense, authorship links researchers with the content of a publication. Indeed, the published report of a work is a fundamental component of the research process because it is the primary method through which researchers convey their specific contributions to the basic and foundational knowledge upon which future research can be built.

From a scientist's perspective, authorship matters because the number of publications and a publishing outlet's reputation are among commonly used indicators of academic success (Anderson et al., 2011; DeSoto, 2016; Kalichman, 2011; Shamoo & Resnik, 2022). Since authorship is often regarded as a measure of productivity, expertise, experience, and authority, it has become an essential element of professional evaluations (e.g., hiring, promotion and tenure), and is taken into consideration in the allocation of funds, salary, and bonuses. Accordingly, because authorship connects a paper with a researcher's name, and the credit associated with it can influence success or failure of an academic's career, decisions about how authorship credit is allocated are among the most common sources of misunderstanding and conflict within research teams.

While resolving these tensions has never been easy, addressing them in international collaborations can be even more complicated. This is relevant because bibliometric records show that international collaborations have been growing in all fields since the middle of the 20th century. This growth has been

most noticeable in disciplines such as astronomy, geosciences, mathematics, biological sciences, physics, and chemistry (National Science Board, 2018).[2] Whether interdisciplinary or international, a growth in collaborations is often attributed to the potential to solve complex or large-scale problems by combining techniques, perspectives and resources unavailable to any one individual, institution or country (Leydesdorff & Wagner, 2008; National Science Board, 2018; Royal Society, 2011). Moreover, the results of international collaborations generally garner more citations per paper than do those of domestic collaborations, suggesting that these publications are more widely read and likely to be more impactful (Glänzel & Schubert, 2004; Leimu & Koricheva, 2005; Persson et al., 2004; Royal Society, 2011).

With an increase in international and interdisciplinary collaborations, tensions related to authorship are exacerbated due to geographical, institutional, and disciplinary differences in authorship norms (Thakur et al., 2011) and can be fertile grounds for misunderstanding and miscommunication. Authorship issues are numerous and complex, but perhaps the most frequent and contentious center around 1) criteria for authorship (e.g., who should be an author); 2) the order in which co-authors' names are listed; and 3) the responsibilities of authors, both related to specific contributions and to the overall integrity of the work. Although there are varied models and suggestions to minimize conflict around these issues (Berg, 2018; International Committee of Medical Journal Editors, 2023; National Information Standards Organization, 2022; Rennie et al., 2000; Resnik, 2009), none is universally enforced or agreed upon.

Further, given the increasing number and diversity of collaborators, reaching an agreement on appropriate assignment of authorship can be notoriously difficult. For example, international collaborations can be prone to tensions and ethical issues due to the adherence of members to different values and principles, and subtle nuances in how they are understood and interpreted (Heitman, 2014;

[2] Data from the US National Science Foundation show that interdisciplinary and international collaborations in particular have made striking contributions to growth in co-authorship over the past several decades. Between 1990 and 2010, the proportion of articles with authors based in at least two departments or institutions grew by 25 percentage points, and between 2006 and 2016, the percentage of US academic publications co-authored with researchers based in foreign institutions increased from approximately 25 to 37 percent. This trend has continued and in 2020, 40 percent of scientific publications from US academic institutions included co-authors from non-US institutions (National Science Board, 2018; 2022).

Redman, 2013; Rockwell, 2002). Collaborators are likely to differ, at least to some degree, in their experiences and, as a result, might have different assumptions and expectations about how authorship should be assigned. Based on the extent and nature of their experiences in different scholarly settings, including their positions in organizational hierarchies, contributors may endorse opposing unwritten norms. Sometimes these unwritten norms reflect the personal preferences or values of those involved in the project (e.g., the lab head is on every paper) and/or specific circumstances (e.g., trainees nearing the end of a postdoctoral appointment might expect to be the first author on the next publication because when they joined the lab as graduate students, this favorable treatment was offered to postdoctoral trainees).

There is abundant evidence of irregularities in, and misuses of, authorship practices. A survey of 8,364 international researchers who had published between 2011 and 2015 showed that 46.6 percent of respondents had experienced problems with, or misuse of, authorship (Smith et al., 2020). Of note is that 63 percent of respondents identified multiple factors for disagreements including "Confusion and lack of clarity (e.g., process or criteria)" and "Lack of discussion and agreement within the team" (Smith et al., 2020, p. 1982). Another international survey that included 2,300 active researchers based in the US and 45,000 based in Europe who were authors of research articles published between 2016 and 2020, showed that nearly two-thirds of respondents admitted to having been involved in questionable authorship practices. Including authors who had not contributed to the work, and those who had neither conducted a thorough review of the submitted manuscript nor supervised the research, were among these practices (Allum et al., 2023). Other surveys and reports have indicated that respondents were often unaware of, did not agree with, or in any case, did not follow existing international guidelines about authorship (Ahmed et al., 2010; Dhaliwal et al., 2006; Joubert, 2005; Mitcheson et al., 2011; Pignatelli et al., 2005).

All of these tensions point to the need for, and potential value of, *Authors Without Borders.* Without aiming to be exhaustive, we combine recent literature about authorship with results from the Authors without Borders project – from interactive peer discussion groups, one-on-one follow-up interviews, and open-ended survey responses – to highlight issues that contribute to controversy and confusion. Subsequently, we use these insights to develop specific points that should be considered when discussing authorship.

2. Authorship

By dictionary definition, the author of a work is the person who has created it (Merriam-Webster Dictionary, 2023), and accordingly, is responsible for its contents. This straightforward understanding of the meaning of "author" has been sufficient for the first several centuries of scholarly research.[3] For instance, in empirical natural sciences, the same person who had a specific curiosity or interest in a phenomenon devised a methodology and developed hypotheses, conducted experiments, wrote a report about the process and ultimately corresponded with an outlet to have it published. As a result, there was no ambiguity about who did what and who would ultimately be responsible and accountable for the published claims. Indeed, sole or dual authorship were the primary modes of authorship for a long time. However, over the last several decades, as scientific research has become increasingly complex, the traditional and straightforward concept of authorship and its concomitant implications have evolved.

The role of authorship in the scientific process

To the extent that authorship enables an iterative interaction between researchers who report research findings and the community which assesses and evaluates these claims (Pera, 1994), it is an integral component of the scientific process. Therefore, without authorship, science would be closed and non-transparent, and the process in its iterative form would cease to exist. This underscores the notion that for science to be effectively communicated and to remain accessible, it needs to be "authored"—be it through journal articles, presentations, or other means.

The view that science must be communicated and authored is also supported by sociologists of science. For instance, for Robert K. Merton, the primary institutional goal of science is to extend certified knowledge (Merton, 1973).[4] The formal process of extending certified knowledge (in the natural sciences)

[3] It is important to note that this does not imply an absence of controversies regarding authorship. Numerous disputes over credit and authorship can be found in the history of science such as the one between Galileo Galilei and Simon Marius over the discovery of the moons of Jupiter.

[4] There is evidence that this goal might not necessarily be endorsed in non-academic environments where financial and corporate interests might conflict with open sharing of research results (Resnik, 2007). However, the present document explores authorship in academic settings wherein the consensus is that science must be communicated and discussed.

essentially involves a combination of some of the following steps in some order: ideation, devising methods, observation, discovery, testing, drafting results, revising, submitting to a journal, having claims challenged through feedback received from peer reviewers, and ultimately, publishing. Although there is space and an appreciation for anonymous science in specific cases, such as places with limited freedom of expression wherein authorship could threaten a scientists' life (Morton et al., 2022; Neuroskeptic, 2013), as will be discussed further, almost no version of conventional and collaborative scholarly science would exist without an indication of involved contributors—be it through authorship, contributorship, inventorship, patents and so on. This is, in part, because anonymous science ambiguates the sources of knowledge and the provenance of ideas, complicates indexing and findability of information, hinders authentication, and prevents the community from holding researchers accountable, all of which are counterproductive to the extension of certified knowledge.

The iterative journey of inquiry and extending certified knowledge typically begins with reading (or being aware of trends in) the literature about a certain topic to identify possible knowledge gaps and avenues for future inquiries. Once a gap is found or an idea is developed, researchers formulate hypotheses or specific questions to investigate. They might then devise appropriate methods to test their hypotheses or explore questions. This can involve designing experiments, setting up observational studies, or developing models, frameworks, or simulations with specific components relevant to the topic of inquiry. This step is followed by actual observations, investigations and/or experimentation. Analysis of empirical data can lead to the discovery of new facts or insights, which may, in turn, result in revising the initial hypothesis or its assumptions. Further testing might then be conducted to ascertain the validity of hypotheses based on observed results, followed by additional statistical analyses or other systematic and rigorous methods. Once observations or experimental findings and analyses are compiled, consolidated, interpreted, and discussed, a manuscript is eventually drafted. The writing process involves a series of requirements about formatting, structure and word count (indicated by the target journal) as well as decisions such as ”who writes the first draft” or ”who reviews what part”, all of which should be made collectively in a collaborative project.

Ideally, a well-written and accurate research paper provides a detailed, open, unbiased, and transparent account of the conducted research and rationale for it. This description would include foundational assumptions, the initial review of the literature, hypothesis development, and research design including the

methods and materials used. It would also report the results obtained, the conclusions drawn, and explicitly acknowledge the limitations of the findings as well as their novel contributions. The drafted manuscript undergoes revisions, often in light of feedback received from co-authors and other colleagues and is ultimately submitted to a journal to be reviewed and, if deemed relevant and acceptable, will be revised based on peer reviewers' feedback (if need be) and finally published.

In short, publication of a manuscript allows other scientists to learn about the research, build upon it, or challenge its findings, thereby driving further progress in a field. Authorship plays a crucial role throughout this entire process because it enables authors to communicate their involvement in research, receive credit and take responsibility for shared ideas, methods, results, and conclusions. Accordingly, authorship is not just a matter of ego or prestige, but a cornerstone of the scientific process.

Who should be an author: Criteria for inclusion and exclusion

When research was conducted by an individual scientist or scholar, there was no need for specific standards of authorship or inclusion and exclusion criteria. However, as science became more complex and collaborative, more author names began appearing on scientific papers. This growth in the number of authors has sometimes led to disagreements about whose contributions should receive authorship credit, and the criteria upon which those decisions were based.

Other factors have also necessitated establishing authorship criteria. For example, some egregious instances of research misconduct (e.g., the case of John Darsee[5]) have fostered extensive discussions regarding the nature and extent of the contributions of co-authors to a given work, and their responsibility for the integrity of the published work as a whole. Furthermore, with increasing

[5] John Darsee, a doctor at the Harvard Medical School and research fellow in cardiology at the Brigham and Women's Hospital, committed extensive scientific fraud in the 1980s, fabricating and falsifying data in numerous published studies, which led to his dismissal and a ten-year ban from federally funded research (Budiansky, 1983). Darsee had been a rising star at Harvard Medical School who included well-known colleagues as authors on his papers without their having made meaningful contributions to the work. In light of data fabrication allegations, many started questioning authorship and wanted to know how Darsee's co-authors could have allowed fraudulent practices to happen. In the discussion that followed, the responsibilities of co-authors for the integrity of scientific research and authorship criteria were debated (Stewart & Feder, 1987).

recognition of science's potential to develop marketable solutions, funding opportunities for research as well as academic partnerships with industry have expanded. This has led to an increasing number of researchers who collaborate with various commercial entities, which may have different norms and practices than those endorsed in academia. In particular, pharmaceutical companies have been involved in numerous cases of ghostwriting, where the actual authors of the study are not credited, and instead, authorship is attributed to famous researchers (who may have made little or no actual contribution).[6] Presumably, these authors are named to lend credibility to the results. In so doing, the reader can be misled with regard to potential conflicting interests of the actual author(s). Considering these challenges, the development and promotion of criteria to define "who should be an author" has been considered as a solution.

The Council of Biology Editors or CBE (which became the Council of Science Editors [CSE] in 2000) was one of the first organizations to attempt to assess what it means to be an "author" and stipulated that

> The basic requirement for authorship is that an author should be able to take public responsibility for the contents…. [This ability] should come from having participated in design of the study, in observing and interpreting the reported findings, and in writing the paper (Huth, 1983, pp. 1-2).

Further, the US National Academy of Sciences indicated in their foundational and pivotal report, *Responsible Science: Ensuring the Integrity of the Research Process, Vol. 1* that

> There is general acceptance of the principle that each named author has made a significant intellectual contribution to the paper, even though there remains substantial disagreement over the types of contributions that are judged to be significant. A general rule is that an author must have participated sufficiently in the work to take responsibility for its content and vouch for its validity (National Academy of Sciences, 1992, p. 52).

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[6] For instance, Wyeth Pharmaceuticals (now part of Pfizer) paid the medical writing firm DesignWrite to write articles that promote hormone replacement therapy, and then invited researchers from different universities to have these papers published under their names (Wilson, 2008).

The requirement of significant, substantial, or meaningful intellectual contribution to specific tasks emphasizes that, besides the degree, extent, and/or importance of contributions (i.e., “significant”, “substantial”, “meaningful”), in order to be listed as an author, a qualifying contribution should be of a certain type, that is, *intellectual*. In other words, one can make significant contributions to various tasks but to the extent that these contributions are not intellectual, one’s significant contributions might not merit authorship. This approach is also adopted by the World Association of Medical Editors (WAME), whose authorship criteria stipulate

> Everyone who has made substantial intellectual contributions to the study on which the article is based (for example, to the research question, design, analysis, interpretation, and written description) should be an author. (World Association of Medical Editors, 2007, para. 2)

Using the notion of “intellectual contributions” raises the question of precisely what constitutes such a contribution. Different views exist about the hallmarks of intellectual contributions. For instance, some have suggested that for a contribution to be intellectual, it should involve creativity or originality expressed in a specific context (Hoey, 2000). Others have linked intellectual contributions to the uniqueness of text and its claims (Biagioli, 2003, p. 262). Other explanations include the role of personal judgment in understanding research questions and applying advanced methodological expertise, generating and interpreting data appropriately, and recognizing the limitations of data when drawing conclusions (Hosseini & Lewis, 2020).

These different viewpoints suggest that reliance on “significant *intellectual* contribution” as the sole criterion for authorship is complicated if not impossible. More importantly, it is inconsistent with the way in which members of the research community attribute authorship, and how other associated parties (e.g., funders, policymakers, the public) understand authorship. This has been particularly the case in medical research. Indeed, early on, the Harvard University Faculty of Medicine emphasized that “… the only reasonable criterion [for authorship] is that the co-author has made a significant intellectual *or* practical contribution.” (italics added; National Academy of Sciences, 1993, p. 128).

Some of these challenges may explain why other widely-accepted definitions of authorship do not include the notion of intellectual contributions. For example, in 1988, the International Committee of Medical Journal Editors (ICMJE)

developed their Uniform Requirements for Manuscripts submitted to biomedical journals, stipulating that

> All persons designated as authors should qualify for authorship. Each author should have participated sufficiently in the work to take public responsibility for the content. Authorship credit should be based only on substantial contributions to (a) conception and design, or analysis and interpretation of data; and to (b) drafting the article or revising it critically for important intellectual content; and on (c) final approval of the version to be published. (ICMJE, 1988, p. 402).

The ICMJE has revised and improved the above-mentioned stipulation frequently, resulting in more specific guidelines and criteria for authorship. As of May 2023, the ICMJE recommends that authorship be based on the following four criteria:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or reviewing it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. (ICMJE, 2023, p. 2)

Despite these ever more precise and specific criteria, various experts have argued that they are not always practical or steadfastly adhered to (Cronin, 2001; Gøtzsche et al., 2007; Kornhaber et al., 2015; Larivière et al., 2016; Moffatt, 2013; Nylenna et al., 2014). In particular, the requirement to be involved in drafting the manuscript or confirming the final version cannot always be fulfilled by all researchers (e.g., in natural sciences, researchers conducting fieldwork might not be interested in, or have the skills to draft or revise the paper). Moreover, lack of involvement in drafting the manuscript is sometimes used as a tactic for excluding authors. Indeed, the requirement to be involved in the writing process *in addition to* other tasks has been questioned and some have recommended that it be removed. For instance, McNutt and colleagues have developed the following recommendations, basically replacing the *AND* between ICMJE's first and second criteria with an *OR*

> Each author is expected to have made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; or have drafted the work or substantively revised it; AND to have approved the submitted version (and any substantially modified version that involves the author's contribution to the study); AND to have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. (McNutt et al., 2018, p. 2558)

In May 2023 all Public Library of Science (PLOS) journals (with the exception of *PLOS Medicine*) adopted these recommendations to grant authorship to a larger set of contributors, such as those who may develop software without necessarily drafting or revising the manuscript (Hoch, 2023).

The Significance of Authorship Order

Both the terms used to describe an author's role, and the order in which authors' names appear, are highly variable. Standard practice, or "convention", can vary with discipline or subdiscipline, and even within a single research group. For example, in experimental physics authors are generally listed alphabetically, though this is not the case in theoretical physics. Partially alphabetical authorship order refers to instances when middle authors are listed alphabetically following the first and before the last who is normally the head of the research team or laboratory group (also known as the "*senior author*" in some contexts). Participants in our peer discussion groups reported that these conventions can be confusing. As one explained:

> *"As a graduate student, the order of individual names was rarely discussed (with me). The senior author was the last author, the person the lab collaborated with was first and as the graduate student who did the majority of the work, I was second."*

Currently, the most common practice and/or assumption about authorship order, particularly in life sciences, is that the first author is the individual who did "most" of the work, that is, the person who made the greatest contribution with regard to the nature and extent of the work. The first author may also be known as the primary or lead author. Most frequently, though not in every instance,

additional authors are listed in descending order of contribution except when the head of the research group is listed last (e.g., in the life sciences). If a publication is primarily based on a student's doctoral thesis, the first author is almost invariably the graduate student.

There may be other variations of authorship order, resulting in conventions that are not consistent or universal. Regardless of endorsed conventions, certain assumptions exist among both readers and co-authors regarding how the authorship order will be interpreted and assessed. Competing and potentially conflicting assumptions can create or exacerbate tensions among authors. There are varying opinions about the significance of authorship order: some associate substantial importance to being the first or last author or at least being as close as possible to these positions, while others downplay its overall relevance, because authorship order is not factored in metrics such as the total number of citations (Ioannidis et al., 2016).

For many, authorship order, and especially being the first author, matters due to the way in-text citations are formatted in some style guides. For example, the American Psychological Association (APA) Style Guide, which is widely used across the sciences, requires –for sole-authored publications– the last name of the first author followed by the year of publication. For works authored by two persons, both names are listed and occasionally all authors are listed for three-authored works. However, for papers with more than three authors, the in-text citation consists of the last name of the first author followed by "et al." (an abbreviation of the Latin "et alia" meaning "and others") and the year of publication. As a result, in the mind of the reader who sees the citation, the first author's name is linked, at least in theory, to the key concepts of the paper and defines how a work will be remembered.

Some institutions and funding sources pay particular attention to first and last authorship in making hiring, promotion, and funding decisions. This was highlighted by one of our peer discussion group participants who noted:

> "*In [country], [country] and [country], researchers are held to rigid publication expectations for appointment, promotion and tenure, and authorship order matters tremendously in some highly competitive fields, leading to bad behavior and credit-mongering.*"

Authorship order aside, each paper should have a "*corresponding author*" who serves as the contact person for all involved contributors as well as the journal

editors during the publishing process, and also for readers and others seeking additional information once the manuscript is published. The corresponding author may be the first author, or – as is more frequently the case – may be the last author or the author with most experience. This is sometimes considered a prestigious title, like first author, as evidenced by the proliferation of co-corresponding author designations (discussed at greater length in the next chapter). However, having experienced individuals as corresponding authors may be a practical choice given the responsibilities involved and the intricacies of communication with the editorial staff. Furthermore, postdoctoral researchers, and especially graduate students, are usually in temporary positions with a range of competing responsibilities (such as graduation and finding a new position), while more experienced and senior contributors generally have permanent positions with administrative assistance and can more easily serve as a primary contact person for a longer time. For multidisciplinary or cross-disciplinary research projects, which produce multiple publications, the first authorship position as well as corresponding authors may rotate depending on the focus of each manuscript and the primary discipline of the target journal.

As with authorship itself, the order of authors in a byline and decisions about who should be corresponding author should be determined by the head of the research group in conjunction with the first author and other co-authors.

The Responsibilities of Authors

Like any role, authorship comes with an array of responsibilities, both explicit and implied, which are partly rooted in assumptions and expectations and partly formalized in codes and guidelines. In particular, authors have responsibilities to themselves, their co-authors, and their readers as well as the larger society. For multi-authored works, every author has the right and responsibility to protect their professional reputation by reviewing and appropriately editing a manuscript before its publication. This is an opportunity to confirm claims, and if necessary, refine, correct, and potentially improve the manuscript in terms of accuracy, completeness, and clarity. In addition, reviewing the manuscript can inform authors about tasks completed by others and enable them to take public responsibility for the manuscript. Depending on the circumstances and extent or duration of involvement, taking public responsibility for the work may consist of being able to explain both the rationale for the work in the context of the current state of a field, and how the conclusions follow from the research findings. For example, individuals deeply involved in the research design process, data

collection, selection of sources and analyses of data, are not only responsible for their specific contributions, but also (to some degree, that is to the extent that they have access to information and can exercise independent judgment) for the integrity of the work as a whole. Indeed, regardless of the role or degree of involvement, all contributors need to be attentive to the overall objectives and integrity of the project. Given the iterative nature of the research process, all contributors should exercise due diligence and employ critical thinking skills, to question the validity and reliability of the methods and techniques used.

More experienced authors also have a responsibility to protect junior researchers, trainees and students from harm, and should, to the best of their ability, attend to the integrity and reliability of their collaborators, the project itself, and the associated manuscript(s). For example, supervisors have a responsibility to help trainees learn about and navigate the publication process. This would include helping them understand how to communicate clearly and effectively with colleagues, how to listen carefully, and how to ensure that all voices are heard. One experienced participant in one of our group discussions noted an example of helping their mentee understand, and avoid offering honorary authorship:

> "*[I] convinced my mentee that honorary authorship is unacceptable. Instead, within the text, we described the person's work with citations and biographical information, giving praise and gratitude to their contributions to the field.*"

Furthermore, maintaining open and transparent communication throughout the collaboration and creating a safe and inclusive environment for international authors are among supervisors' responsibilities. This can entail regular meetings (at times that work for everyone, including those who might be in different time zones) and inclusive communication within and between collaborating teams regarding various elements of the collaboration including, but not limited to, the manuscript's aims, the methods used, and possible modifications along the way, as well as recognition of contributions through co-authorship or acknowledgements.

Additional responsibilities associated with authorship are to the readers of published work. The readership falls into two broad categories: those within the scientific, engineering, and technological communities, and those outside this specialized group, including the general public. For those within the academic community, authors have a responsibility to ensure that their manuscript's content is situated in the context of previous work. Towards this end, authors

must ensure that relevant literature is accurately cited and properly referenced, regardless of whether that literature supports or opposes their findings. Furthermore, given that the published manuscripts may lay the foundation for future work (both for the authors as well as other researchers in the field), it is essential to openly share all data and supplementary documentation, identify critical underlying assumptions and limitations, and describe the research process in sufficient detail and clarity. Another responsibility authors have to their readers is to reflect on and disclose any potential conflicting interests that might, consciously or unconsciously, influence the interpretation of research findings, or even data collection procedures and/or research design. Relevant conflicting interests are not simply financial but may be in the form of biases one invariably brings to their work. These may include, for example, confirmation bias for one's favorite theory, and anchoring bias tied to initial assumptions or the experimental results of a pilot study.[7]

An additional responsibility of authors is to explicitly highlight the limitations of their research findings and, when possible, specify potential risks and the possibility of harmful as well as beneficial applications (frequently identified as "dual use"). This responsibility acknowledges that research findings, like technologies, can, appropriately or not, be used and misused in the development of public policy and products in the marketplace (e.g., the use of functional magnetic resonance imaging for lie detection in the legal system).

One justifying rationale for these responsibilities is that basic research and applied research are almost invariably supported with public funds, either directly or indirectly (through taxes and donations to foundations, and, in addition, applied research draws on and relies on publicly funded basic research). More importantly, research is carried out (explicitly or tacitly) in the name of, and with the encouragement of society (e.g., research to develop COVID-19 vaccines). For these reasons, researchers have a responsibility to recognize and address the explicit ethical standards of society regarding the conduct of research. For example, there are regulations regarding the ethical involvement of humans and non-human animals as research subjects, as well as the environmental impacts of research. In their role as authors, it is important that researchers

[7] These are sometimes referred to as myside bias (causing individuals to favor information that confirms their pre-existing beliefs) and self-selection bias (causing individuals to selectively seek out or be more receptive to information that aligns with their preferences and beliefs).

acknowledge their responsibility to uphold society's ethical values. In so doing, they go some way toward justifying society's trust in the scientific community.

These responsibilities have been highlighted by different guidelines. For example, in their 1983 Style Manual chapter, "Ethical conduct in authorship and publication," CBE makes clear that, in accepting an authorship credit, an individual affirms that, to the best of his or her knowledge, 1) the paper includes only and all observations actually made, 2) the paper adequately ties the study presented to previously published work, including conflicting evidence "to help readers judge the soundness of the conclusions stated in the paper" (Huth, 1983, p. 2), and 3) the standards of ethical conduct of research have been adhered to regarding human and non-human research subjects. In the ICMJE's 2013 iteration of Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals, a new requirement for accountability was added to the criteria that should be met in order to qualify as an author:

> Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved (ICMJE, 2013, p.2).

Introducing this requirement seems to have been aimed at reinforcing the link between authorship and accountability. This reminds scholars of their responsibilities to exercise due diligence in ensuring the integrity of work carried out by others, especially their collaborators, and underscores the necessity of remaining responsive to inquiries regarding other contributors' involvement in the manuscript (Alfonso et al., 2019). That said, within large collaborative projects, the possibility that all co-authors would know or understand (let alone be able to assess and vouch for) others' tasks is rather low (Hosseini et al., 2022a).

Implications of authorship within and beyond the research community

Ethical publication practices are essential to the responsible conduct of research. When results and methods are reported transparently, there is a positive impact on the efficiency of the scientific process, and the credibility of authors (Jakobsen et al., 2004; Lauer, 2016; Steneck, 2006). One way of promoting ethical publications is by increasing awareness of the array of authorship guidelines among all researchers (both trainees and supervisors) and among administrators of academic institutions and funding agencies, who in part

contribute to the work climate that may affect ethical and collaborative decision-making (Santos et al., 2015). Regularly reminding team members about authorship standards and clarifying expectations at the beginning of a collaboration with external parties are best practices to ensure that everyone is in agreement about authorship standards, as one of our participants highlighted:

> *"Authorship criteria are shared with students and all collaborators annually. New collaborations establish shared criteria for the duration of the collaboration."*

However, awareness of authorship criteria alone is not enough, especially if the criteria are not respected by all parties, or the awareness cannot be acted upon. For guidelines to be respected, they need to be discussed and agreed upon by the involved parties, and reflect best practices, but this is not always the case (Claxton, 2005; Gristina et al. 2023; O'Mathúna, 2022; Steneck, 2006). There is often skepticism towards guidelines as they can be seen as "external, superimposed, artificial and unrealistic" (Consoli 2008, p. 240). This perception stems from the fact that guidelines are sometimes disconnected from the day-to-day realities of scientific research. For example, researchers engage in a wide array of activities, many of which are nuanced, context-specific, and nonlinear. When guidelines do not adequately recognize these nuances, they can be seen as unrealistic or overly rigid, making them appear more aspirational than practical, and thereby weakening their intent as guidelines that should be followed. Indeed, the impression that guidelines are aspirational can limit their effectiveness, hinder adoption, and result in having them disregarded by researchers. For guidelines to be respected and adhered to, they need to align with accepted practices and be frequently updated.[8] In terms of the impact of authorship beyond the research community, to the extent that authorship practices affect the integrity of publications, they affect the credibility of the scientific community in the eyes of the public. Controversy and tension in the scientific community, not only about the validity and reliability of data and ethical practices (see e.g., Tuskegee [Brandt, 1978], the Chinese CRISPR twins [Normile, 2018]), but also about authorship (see e.g., HIV France vs. US [Altman, 1987]) can undermine the public's trust in science. Further, a general lack of trust among members of the public and policymakers can have repercussions for public acceptance of policies

[8] For example, since 1988 when the ICMJE communicated their first definition of authorship, their guidelines have been updated 19 times (until the time of writing, 2023) in response to how collaborations and other ancillary norms have evolved.

built on scientific findings and affect governmental support for funding. Examples of distrust in scientific findings and misalignments between policymakers and researchers were evident during the COVID-19 pandemic, especially regarding vaccine efficacy and masking requirements (Barocas & Gandhi, 2020).

Recognizing contributions in the acknowledgements section

The acknowledgements section provides an opportunity to recognize contributions that did not satisfy authorship criteria (Cronin, 2005). However, acknowledgements are not standardized, nor are they counted like citations or tallied like authorship credit. Accordingly, expressions of praise and recognition in this space remain subjective, unstructured and rather arbitrary. Sometimes acknowledged contributions are of a valuable and necessary nature, and yet, are not recognized among contribution types that warrant authorship credit. For instance, according to the ICMJE recommendations:

> Activities that alone (without other contributions) do not qualify a contributor for authorship are acquisition of funding; general supervision of a research group or general administrative support; and writing assistance, technical editing, language editing, and proofreading (ICMJE, 2023, p.3).

In other situations, the reason for being mentioned in the acknowledgements section could be due to the extent of contributions. When relying on authorship guidelines that, among other criteria, require *substantial* contribution to certain aspects of the work (e.g., data collection), an insufficient contribution might be the reason to mention someone in the acknowledgements. The extent of contributions may be measured by proxies such as the duration of involvement, impact on the overall progress, or other context-specific indicators.[9]

[9] For example, a collaborative data collection effort may involve five researchers and a college intern. While the five researchers may devote several months or even years to the project, the intern's involvement might span only a few weeks. When considering the extent of contribution from the perspective of duration of involvement, relative to researchers who are involved for a longer period, extent of the intern's contribution could be deemed as insufficient, and accordingly, be mentioned in the acknowledgements section. Nevertheless, this is not to say that the intern's contribution was insignificant or not useful. In scenarios like this, awarding authorship to the intern might lead to perceptions of unfairness among the researchers who have been involved for a longer time, because authorship has been granted without commensurate effort.

Other examples of contributions that could be mentioned in the acknowledgements pertain to providing feedback on early drafts of a manuscript, questionnaire, or grant proposal, and offering various types of resources such as data, samples or equipment without being involved in the entire research process. Many of our participants shared experiences about instances when recognizing contributions in the acknowledgements section was more appropriate than receiving authorship credit, as captured in the two examples below:

> *"I was offered authorship for some initial research ideas from a researcher who worked for me. I refused as the paper went far beyond my knowledge in the field. An acknowledgment was more than enough."*

> *"The researcher from my team spent three weeks preparing an essential reagent needed for the research in the lab focusing on another subject than mine. The authorship was declined and the researcher from my team was thanked in the acknowledgements section."*

Regardless of the reasons for including someone's name in the acknowledgements section, authors must ensure that those being acknowledged are both aware of, and agree to, their inclusion, "because acknowledgment may imply endorsement by acknowledged individuals of a study's data and conclusions" (ICMJE, 2023, p.3). It is the responsibility of the corresponding author to obtain written permission from all acknowledged individuals, specifically indicating that they agree to be mentioned. Some journals (e.g., *Research Ethics*) specifically require that these permissions be submitted as a supplemental document.[10]

Specifying individual contributions

Whether a contributor satisfies authorship requirements, or they are mentioned in the acknowledgements section, it is important to highlight their contributions. For a long time, acknowledgements or authors' notes sections were used for this purpose, providing a space for highlighting specific contributions with free text.

[10] The author guidelines of the journal of *Research Ethics* notes "Contributors or advisors who do not meet the criteria for authorship can be listed in an Acknowledgements section. Examples of those who might be acknowledged include a person who provided purely technical help, general support or feedback on an early draft. Please ensure that persons who are acknowledged have given permission for mention in the article and upload their confirmation (as supplementary materials) at submission" (Sage Journals, 2023).

However, since these statements were unstructured and not always mandatory to report, many voiced concerns about their usefulness. Particularly, it was argued that since these statements are not machine-readable, they cannot be readily indexed, discovered, and reused (Craig, 2018; McNutt et al., 2018). Consequently, a different solution for specifying contributions was required. Contributor Role Ontologies and Taxonomies (CROTs) are the most recent solution that address this issue by offering a standard list of roles to specify individual contributions to publications and enhance transparency and consistency of reporting conducted tasks. For example, the Contributor Roles Taxonomy (CRediT), which is widely adopted by journals, consists of 14 standard roles including conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing (original draft preparation), writing (review and editing), visualization, supervision, project administration, and funding acquisition (Brand et al., 2015). Using CRediT is believed to improve the attribution of credit and responsibilities and can positively impact collaborations. As a result of CRediT's success, various discipline- and context-specific CROTs (e.g., TaDiRAH for Digital Humanities projects) have been developed to describe contributions in unique settings (Hosseini et al., 2023a).

3. Detrimental and Challenging Authorship Issues

As may be apparent from the preceding chapters, there are few universally-accepted authorship practices or policies. That said, there is a continuum from preferred to acceptable to unacceptable practices and these practices may vary depending on geography, discipline and institution. Furthermore, like research practice in general, authorship practices are evolving. When considering various authorship practices, their history, underlying assumptions, consequences, and impact are key to understanding and explaining why practices are falling out of favor, or, on the other hand, why certain others are increasingly adopted. It is also worth noting that because authorship is mostly reported by corresponding author(s), identifying unacceptable practices remains complicated (with the exception of plagiarism[11]) and dependent on what the corresponding author(s) would be willing to disclose. In this chapter, we highlight some of the detrimental and challenging authorship practices that were mentioned in the Authors without Borders project and recent literature.

Detrimental authorship practices

Because there are few universally-accepted, hard-and-fast rules regarding authorship, and because authorship plays a central role in professional development, evaluation and advancement in academia, various problematic practices have developed over the years. The rationale and motivation for such practices vary but they all distort one or more of the basic elements of the generally accepted purposes of authorship, that is, to appropriately assign credit and responsibility for published work. There are a number of terms, some used interchangeably, that identify the general class or specific type of inappropriate authorship including guest or courtesy authorship, gift authorship, honorary authorship, legitimizing authorship, ghost authorship, and surprise authorship.

Gift authorship

Gift or courtesy authorship is the practice of including an individual in the list of authors who has made little or no contribution. Sometimes these attributions act as reciprocal gestures offered in courtesy of past favors or in anticipation of

[11] One reason why the scientific community has had some success in enforcing policies regarding plagiarism pertains to the use of technology to detect plagiarized text.

future exchanges, such as providing research samples or inclusion in another publication. Several participants in our group discussions described their frustration with such instances, as outlined below:

> "*My postdoctoral supervisor asked to have a colleague included as an author in a paper in which he had no contribution. In the end he was included as a co-author to boost his chance for tenure and promotion.*"

> "[Including as author] *a former "mentor" that didn't do more than having conversations about the initial idea of the project and giving advice (brainstorming).*"

If the "gift" is a surprise (also called surprise authorship) and the recipient is unaware of the "honor" before receiving a confirmation email from the editorial office, or seeing the published manuscript, then they have no opportunity to consider and accept or reject the gift authorship or its inherent responsibility, however well meant. A participant in our study said:

> *"My mentor put my name in the middle of the six- or seven-authors on a paper … which I had made no actual contribution to."*

Whether these acts of reciprocity are implied, explicit and agreed upon, or, a well-intended surprise, gift authorship falsely implies a relevant contribution to, and associated responsibility for, the work.

Honorary authorship

When authorship credit is given to high-status institutional, or organizational officials (as is sometimes required or expected by local custom), attribution of credit and responsibilities are distorted. Honorary authorships are not given for direct contribution to a project, but rather for contributions, such as providing resources (e.g., laboratory space, facilities, or equipment) that may be only tangentially related to the particular work of a specific manuscript. Other times, honorary authorship may be offered to a high-status individual who has only provided feedback on an idea or manuscript, comparable to what a peer reviewer would have offered.

We received responses that described various contexts and settings for honorary authorship, including those below:

> *"In [some] countries, there is more of a tendency to include senior individuals as 'honorary authors'. Resolution is often not reached, in the sense of having everyone feel that they have been treated appropriately."*

> *"A department head in [country x] was listed on a paper ([country x]-[country y] collaboration) as an honorary author simply for providing space for the research."*

Regardless of the context and reasons for honorary authorships, these are offered to high status individuals who do not satisfy widely-accepted criteria for authorship (Flanagin et al., 1998).

Ghost authorship

Ghost authorship refers to a situation where individuals who made significant contributions to a project are not listed as authors. Ghost authors could be a member of the core team or an external contributor who was temporarily involved in one (or more) specific task(s) like writing the manuscript or conducting statistical analysis. A participant in one of our group discussions mentioned such an instance:

> "*A research project coordinator who was intimately involved in the project was omitted from the list of authors…*"

In some cases, an individual may be hired to write or rewrite a manuscript for authors who do not have the necessary time or ability to write clearly in the language/style required by the journal. Depending on the extent to which a ghostwriter is familiar with scientific vocabulary, methods and the research involved, and is able to meaningfully engage with the core group, they can improve the accuracy and reliability of the work. These writers/editors should be identified, with their permission, in the acknowledgements section whether or not they have been paid for their service. Much more problematic is a ghostwriter who is not independent but rather, for instance, is an employee of a funder or other private sector collaborator with specific interests in the manuscript and its contents. An example was highlighted in group discussions by one participant:

> "*Within the pharmaceutical industry, some key scientists are occasionally not recognized for their contributions to clinical manuscripts.*"

In these cases, it is possible that the writer (or their employer) may have a vested interest, indeed a potential conflicting interest, in the interpretation of data, conclusions drawn, or recommendations made in the paper. Their omission from the list of authors denies the reader potentially meaningful information in terms of involved interests that could affect evaluation of the paper's conclusions.[12]

Legitimizing authorship

Legitimizing authorship refers to the practice of assigning authorship to a respected or well-known figure in a field, without direct or substantial input to the work. This is often done with the intent to boost the credibility, visibility, or acceptance of the paper within the scientific community, leveraging the reputation of a well-known author. While this person may provide some level of oversight or general guidance, their specific contribution to the actual content of the paper could be minimal or non-existent. Nevertheless, their presence in the byline might result in faster and more favorable reviews, or a warmer reception and more citations once the manuscript is published.

Challenging authorship practices

Group authorship

Sometimes called group authorship, corporate authorship or team authorship, this form of attribution is used by citizen scientists or "multicenter study investigators, members of working groups, and official or self-appointed expert boards, panels, or committees, who wish to display a group name to indicate authorship" (Fontanarosa et al., 2017, p. 2434). Group authorship is often used in large-scale research projects or studies that involve numerous contributors who have chosen to use a collective group name, rather than individual names, to represent authorship. Statistical Reports on MEDLINE/PubMed Baseline Data shows that group authorships are rising. While from 2000 to 2004 only 29,588 articles had a group author in their byline, from 2015 to 2019 this form of authorship attribution had increased to 77,698 articles (US National Library of Medicine, 2023). Widely used authorship guidelines such as those provided by

[12] In some rare instances, ghostwriting may be justifiable for safety and/or security reasons arising from sensitive research into political or religious issues (Anderson et al., 2011; Morton et al., 2022). Under these circumstances, individuals may voluntarily choose to remove themselves from the list of authors. This should be agreed to by all co-authors and the editor of the target journal.

the ICMJE provide the following suggestions regarding group authorship attributions:

> Some large multi-author groups designate authorship by a group name, with or without the names of individuals. When submitting a manuscript authored by a group, the corresponding author should specify the group name if one exists, and clearly identify the group members who can take credit and responsibility for the work as authors. (ICMJE, 2023, p.3)

Two challenges associated with the use of group authorship are noticeable, namely ambiguities about involved group members in a project, and the exact contributions of each member. When using group authorship, some papers list all involved members of their group in an acknowledgements section or elsewhere in the manuscript, but this practice is not steadfastly followed. When group members are not listed in a paper, it is impossible for readers to clarify those who were involved in the project. In relation to what any given group member did, even in cases when members' names are mentioned, their contributions can remain undisclosed, and therefore unclear. While group authorship attributions are not unethical, in cases when group members or their contributions are not clearly described, attributions of credit and responsibilities are blurred.

In relation to the distribution of credit, this lack of clarity can lead to issues similar to "ghost" or "guest" authorship, where individuals who did *not* make a significant contribution to the work can take credit under the umbrella of a group name, or, those who did contribute significantly and would have deserved individual authorship are listed under a group name. Furthermore, group authorships make it difficult to hold specific individuals accountable if research misconduct or errors are later discovered. To avoid such issues, when using group authorship, the corresponding author should transparently disclose members' names and delineate individuals' roles either in the acknowledgements section or as a supplementary document.

Equal co-authorship

Equal co-authorship refers to crediting multiple authors as first (co-first) or corresponding (co-corresponding) authors, implying that certain individuals made "equal contributions" to a paper with regard to various tasks and responsibilities that determine eligibility for authorship (see above). Equal co-authorship (especially equal first authorship) has gained increasing prominence in recent years. In 2009, Xiaojun Hu raised concerns about the rise of this form

of authorship recognition in biological chemistry (Hu, 2009) and since then, various other scholars have measured the growth of this trend in their respective disciplines and highlighted the associated challenges (Hosseini, 2020).

Equal co-authorships raise several ethical and practical challenges. Among others, it is not always clear and evident whether multiple authors can make *exactly* equal contributions to a research paper. For example, consider the scenario of a review paper with references evenly divided among two co-authors, where each is assigned an equal number of references to review and analyze. Despite this seemingly equal division, disparities may arise due to differences in paper length, or the depth of analysis required. Hence, achieving *absolute equality* in co-authorship contributions is inherently challenging, if not impossible. In this sense, the claim to equality could be seen as moot and purely based on consensus or negotiation rather than an objective, quantifiable measurement of individual input (Moustafa, 2016). Some of our peer group discussion attendees shared both positive and challenging experiences:

> *"Someone in the team did a significant re-analysis and re-write for a paper. One senior author and myself wanted this person to be first author on the paper. Collaborators wanted two trainees to be co-first-authors on the paper in order to aid their careers. The end result was that the trainees were co-first-authors. I remain uncomfortable with that decision because my perception is that the first author is the person with the largest contribution to both the writing and the data collection/analysis."*

> *"In collaborations of computational and experimental collaborators, it is not always clear who should be the first author. If this is not decided before the manuscript is drafted, this can cause conflicts. Typically resolved with co-first authorship and by publishing multiple manuscripts."*

That said, some have argued in favor of these practices, pointing out that co-first authorships are sometimes used as an instrument for resolving tensions or aiding researchers with their careers (Hosseini & Bruton, 2020; Resnik et al., 2020). For example, regarding co-first authorships, it is argued that in cases where more than one co-author has made a significant contribution throughout the project, this form of attribution allows a fairer recognition of individual contributions and prevents tension (Conte et al., 2013). In relation to co-last authorship, it is argued that within multi-disciplinary and multi-site projects where different levels of

supervision are required, co-last authorship recognizes that the project and various parts of the work were managed by different authors (Alfonso et al., 2019). This was highlighted by an attendee of our peer group discussions:

> *"Rarely have I seen conflicts over who is the first author or the corresponding author. We usually resolve this by making them co-first or -corresponding authors."*

At the same time, while in principle, multiple co-authors could be called equal, in practice, one author will be the more prominent — in the case of multiple equal first authors, the first named author (i.e., the first of the co-firsts) and in the case of equal last authors, the last of co-lasts.[13]

While these practices attempt to address the tension about authorship order, they may add a new layer of complexity to these discussions; in addition to clarifying who should be first, or corresponding author, a new discussion needs to happen about who should be the first of firsts and which responsibilities fall to which corresponding author. This issue was mentioned by one of our peer discussion participants:

> *"Many times [I] have faced disagreements among junior researchers about who should be first author, or co-first author. [These issues are] resolved by discussion with me as the senior author and group leader; not always amicably, but usually."*

The fact that equal co-authorships are not consistently reported and recognized by different journals, publishers and scholarly indices means that in cases where these attributions are justified or needed to resolve tensions, they are not always an available option. This issue was mentioned by a peer group discussion attendee:

> *"There were two junior researchers, one a postdoc and one an MS student, who both wanted to be the first author, each from a different research group. Both individuals had excellent arguments to be first*

[13] In the case of co-corresponding authors, only one of them, the submitting corresponding author, will communicate with the editor to which the manuscript is submitted. This person is responsible for pre-publication tasks such as confirming that all authors agree with the submitted version of the manuscript, managing responses to reviewers' comments, and coordinating the correction of proofs prior to publication. After publication, all co-corresponding authors may be willing to serve as the contact person for queries about the published paper from readers or other interested parties.

> *author. The leader of each group decided to tailor the manuscript to submit to a well-known journal that recognized co-first authorship and all was resolved."*

Furthermore, while equal co-authorships are increasingly common, they remain loosely regulated, and different journals have adopted different policies. For instance, some journals have banned it, some have restrictions about the number of equal co-authors while others have no limitations at all. The same could be said about evaluation of these authorship attributions and the way they are interpreted by academic tenure and promotion committees or funding agencies. Currently there are no standards for how equal co-authorships are assessed in these processes.

Senior authorship and "last" authorship

While the term "senior authorship" is widely used, it is not always understood in the same way by everyone in academia. There is an inherent ambiguity surrounding this term and its definition because it is unclear whether the "senior" author is the first or last author in the byline, the oldest author, the most experienced, the one who obtained funding, the one who conceptualized the work, the one who supervised the work, or the corresponding author. Moreover, the specific role, duties and responsibilities of a senior author are not always clear. These ambiguities can be confusing for researchers, especially for early career researchers or international researchers who may have never met the senior author or might not know why they are considered "senior," and what this seniority implies. Participants in our peer discussion groups alluded to some of these issues:

> *"I have no idea what 'senior author' actually means."*

> *"Senior author is a wholly invented artifact."*

> "*In my experience and understanding of this, the person who contributes the most to the writing is always the senior author, though there have been exceptions, especially when a lead person is on a project (who may be the lead because of their position, yet not contributed very much to the project).*"

Furthermore, "last author" and the responsibilities associated with it are potentially ambiguous. Even without any other descriptor (e.g., "corresponding author"), last authorship is considered a prestigious designation, as evidenced by

a proliferation of “co-last” authorships, and tensions around who should be the last author.

Using artificial intelligence to write scholarly publications

The introduction of ChatGPT in November 2022 has increased the use of artificial intelligence (AI) and encouraged many scholars to experiment with it. However, using computer-generated text in scholarly publications started long before the introduction of ChatGPT. In 2021, it was estimated that nearly four in every one million publications was likely generated by computer (Cabanac et al., 2021). AI applications such as BARD, ChatGPT, Claude, ELICIT and many others can analyze and summarize existing text and write grammatically correct passages in response to provided prompts. These tools have sparked discussions about ethical considerations in the scholarly community (Temsah et al., 2023). Thus far, some journals like *Science* have banned the use of these tools altogether (Thorp, 2023) but others such as the *Journal of the American Medical Association* (*JAMA*) (Flanagin et al., 2023) and *Accountability in Research* (Hosseini et al., 2023b) have stated that as long as researchers are transparent about their use, understand that they are ultimately responsible and accountable for any mistakes, and provide clear and transparent citation and referencing, they can use AI systems.

Adopting a lenient approach towards using AI in scholarly publications is based on three arguments. First, banning these tools is unenforceable and some researchers will find ways to use them even if they are banned. Second, banning them is likely to lead to clandestine use of AI which, in the long term, would be counterproductive to the integrity of research. Third, using AI systems may improve equity in science by helping those who write in languages other than their first language (Hosseini et al., 2023c). In particular, AI can potentially help international researchers write more clearly and concisely and, thereby, perform better when communicating their research. When using AI to write scholarly publications, researchers must ensure that the generated text is factually accurate and does not reflect biased views. Indeed, these systems are relatively early in their development and can generate biased and discriminatory texts in addition to errors in reasoning, logic, and arithmetic among others (Borji, 2023).

4. Causes of Controversy and Confusion

While authorship can be key to professional advancement, it can also be a source of controversy, misunderstanding and tension. This is largely because there are variable and conflicting conventions, practices, expectations and even policies. For instance, due to differences in terms of how research and collaborations are understood, practiced, managed, funded, and regulated, what are deemed acceptable authorship practices in one country might be frowned upon or be considered totally unacceptable in another country (Hosseini et al., 2020). When team members come from backgrounds that have differing criteria, conventions, customs, or rationales for authorship, they may have different expectations and trouble agreeing on allocation of authorship credit (Vasconcelos et al., 2014). These differences are not always made explicit, though they are often assumed to be universally known and applicable. Beyond miscommunications and misunderstandings, controversies and disputes may be fueled by unexpressed conscious or unconscious, and potentially unrealistic, expectations and assumptions, as well as possible differing values and worldviews. In addition, confusion and conflicts can arise as a result of unexpected developments in the project, or in the personal or professional lives of researchers. In theory, most of these circumstances could be navigated with open, clear, and transparent communication, but in practice, effective communication that addresses all sources of conflict is rare, because various issues might affect expectations and assumptions about authorship or the tone of communication. In this chapter, we highlight some of the factors that contribute to controversy and confusion.

Varying moral values and norms in international contexts

Depending on interpretation of certain moral values in specific geographies, different researchers may implement norms and standards of research in dissimilar ways. For example, differences in customary ways to demonstrate respect might lead to offering a senior colleague a position in the byline, rather than highlighting their actual contributions to a particular project in the acknowledgements section. Furthermore, nuances in terms of how social constructs and the role of institutions or hierarchical figures are understood, or adoption of different approaches towards time and deadlines, gender issues, and collaborators' personal styles of interaction can create tensions among international researchers. While some of these issues might also be present in domestic collaborations, they are much more pronounced in international contexts. This could be due to communication barriers (e.g., language

proficiency), different belief systems and worldviews, different degrees of access to digital infrastructure, or information literacy among researchers from various backgrounds. Some participants' comments showed that even tensions between countries where authors are based could be a source of frustration:

> *"Western countries impose their ideals of authorship on the rest of the world, they assume their ethics are the right ethics and others are backwards."*

> *"Senior professors in traditional cultures who did nothing but insisted that it was their right by seniority, even to the point of the PhD student or post-doc in their lab being excluded."*

Therefore, with increasing international collaboration, there is need for a greater awareness of different conventions, norms, and standards of ethical publication practices, so that collaborators can discuss and clarify their positions regarding specific authorship questions (Berg 2018; Bosch, 2010; Resnik, 2009; Smith et al., 2014; Vasconcelos et al., 2012; Wager & Kleinert 2014). This necessitates recognition and acknowledgment of, and sensitivity to, deeply rooted authorship variations, which could be specific to a research group, department, discipline, institution, or country (Al-Herz et al., 2014; Macfarlane, 2015; Yukawa et al., 2014).

Internationalization and increased number of authors per publication

As research questions have grown increasingly complicated and sophisticated, it has become more common to collaborate with researchers from across the globe who play varied roles within projects (Feng & Kirkley, 2020; Oliver et al., 2018; Zietman, 2017). Furthermore, parallel with increased collaboration, non-academic parties (e.g., industry, governments, foundations) have increased their investment in science, allowing projects to procure intricate, complex, and expensive machinery and tools, which need technicians to develop, fine tune, operate and maintain (Gibbons et al., 1994; Resnik, 2007). Some of these technicians are ultimately named as authors (Welker & McCue, 2007). At the same time, the internet and advancements in telecommunication technology have made it possible to collaborate asynchronously and communicate with international collaborators. This increased availability of resources and an international research workforce have often led to the appointment of project managers, in addition to increasing the number of administrators and supervisors, as well as principal investigators, to ensure smooth collaborative workflows

(Alberts, 2010; Charlton, 2008). As a result, the number of collaborators in scientific projects has grown at an ever-increasing rate, as has the number of co-authors. Indeed, since the 1980s, the average number of authors per publication has increased significantly across all disciplines (Fanelli & Larivière, 2016). Some have raised concerns about an overexpansion of authorship bylines and warned that papers with hundreds of authors can undermine the notion of authorship (Cronin, 2001) and make ethical tensions more complicated to address (Hosseini et al., 2022a).

Collaboration between junior and senior researchers

Power imbalances often manifest themselves in various ways when junior and senior[14] researchers collaborate. Unequal access to resources and vantage points as well as precarious work conditions could place researchers at opposing ends of the privilege spectrum in academia (Azevedo et al., 2022). In addition to access to more material assets such as funding and research facilities, senior researchers possess more intangible assets such as reputation and influence within the scientific community, which could positively affect a research project's reach and impact. A senior researcher who acts as a principal investigator (PI) can influence team dynamics, authorship byline and order, and the way in which a collaboration proceeds.

In international collaborations, senior researchers may facilitate mobility and offer support (e.g., recommendation letters) that could positively influence the future career of junior researchers. That said, not all senior researchers in an international collaboration have one-on-one contact with all junior researchers. As a result, co-authors might never have met or had any meaningful contact to facilitate empathy and a personal relationship, thereby making the power imbalance seem even greater. Several participants in our group discussions provided comments alluding to the impact of power imbalance on authorship:

> *"In several labs and in industry, the lead had the habit of being final reviewer and senior author whether or not they were part of the specific research, but believed since they were ultimately responsible they should be listed on every publication. [This is]most often seen internationally."*

[14] Here, "senior" means "more well-established and advanced in their field" and is not meant to indicate the senior or corresponding author.

> *“A senior member of the institution requested listing as an author on a project to which he had contributed nothing. His sole relation [to the project] is that the first author directly reported to him. He was granted authorship.”*

> *“A senior author who had not been involved in research I conducted with colleagues asked that his name be put on our publication on the basis that the work had been done in his laboratory. The three of us discussed the issue, and while I disagreed about the basis for authorship, I respected his opinion and agreed that "his lab, his rules" was fair, given we had not discussed the issue previously.”*

While senior researchers can sometimes choose what part of the work to be involved in and can delegate other parts, junior researchers are not in a position to choose and more often than not, have little if any room to negotiate. Furthermore, senior researchers might have privileged access to more information and could initiate and shape discussions about authorship. On the other hand, junior researchers may sometimes find themselves not fully included in key discussions about authorship as well as other aspects of the collaboration or may receive verbal assurances regarding their position in the byline that are not always honored.

To minimize tension and controversy, it is vital for authorship discussions to include all involved contributors. It is also beneficial to document conversations about authorship, whether in written form or, if conducted via video calls, through (mutually consented) recordings. This will make it possible for early commitments to remain part of the continuous discussions about authorship.

Narrow and broad consideration of contributions

From the perspective of those engaged in fundamental research tasks such as data collection and analysis, and initial manuscript drafting, these contributions may be seen as the most important tasks of a project. However, when considering the overall trajectory of a project, contributions can encompass a wider range of crucial and time-consuming activities, which might have started months or years prior to data collection/analysis or manuscript development. To more fully appreciate this issue and explore how it could contribute to controversy and conflict, it is useful to make a conceptual distinction between a narrow consideration of contributions that keep tabs on *current and visible tasks* (e.g., the postdoc did this experiment, conducted this task or wrote the paper) versus a

broader consideration of contributions that acknowledge the full spectrum of involved *processes*. For example, after several online brainstorming sessions and failing to generate noteworthy ideas, a one-day workshop was organized to conceptualize the idea. In the following three months, a grant application was submitted but was unsuccessful. Upon revisions and submission in the next round, the grant was awarded. This made it possible to hire staff and postdocs to conduct experiments and produce data, and eventually write the paper. All of this lays the necessary foundation for both future research and continued support for staff and postdocs. In the former consideration, fundamental research tasks and writing the manuscript are seen as the most important contributions, whereas in the latter consideration, they are a few milestones among many other objectives.

Especially in the case of funded international projects with a PI (or several PIs) who applied and received funding, every contribution will not be visible at all times. Funded projects may start with the submission of a letter of intent, followed by full submission of a lengthy application which might include but is not limited to narrative resumes, a description of ideas with timelines and objectives, planned deliverables and budget for each specific task and institution. Once a grant is awarded, PIs start preparations such as ensuring monetary agreements among institutions, hiring researchers, coordinators, and administrative staff, procuring equipment and consumables, making travel arrangements to meet collaborators or check other resources and equipment, and also dealing with numerous financial and administrative parties just to get started. In international and multi-site collaborations, ironing out these details can be so cumbersome that several coordinating and administrative employees might be required to run the project. These human resources are not always available, especially for junior PIs who have recently established a laboratory or research group, or for small projects. In such instances, in addition to research tasks, the PI must conduct administrative tasks, which in more established research groups or larger projects are carried out by personnel hired for that purpose. When a researcher joins a funded project, many of these details are resolved because PI(s) have spent several months or years planning the project and general direction of research, to ensure that once new hires start, there are few barriers to carry out plans and achieve goals. However, because these contributions happen at different stages and by different actors who might not always be in contact with one another or appreciate these tasks, misunderstandings are not uncommon (especially among researchers who acquired funding and secured other resources, versus those who carried out experiments and wrote the manuscript). Several

attendees in our group discussions highlighted issues that demonstrated these narrow and broad considerations of contributions:

> *"A senior researcher required a student to add her as an author while that person did none of the writing."*

> *"In collaboration with my former PhD advisor, [an assistant professor] insisted on the last authorship because he provided most of the funding for the work. He did not contribute intellectually to the work and did not give any feedback on the manuscript."*

What makes some of these issues even more contentious is that, while funding is necessary for research to be carried out, it is often identified as a contribution type that is *not* sufficient for gaining authorship credit. This is specifically mentioned in some widely accepted guidelines such as those offered by the ICMJE:

> Examples of activities that alone (without other contributions) do not qualify a contributor for authorship are acquisition of funding; general supervision of a research group or general administrative support; and writing assistance, technical editing, language editing, and proofreading (ICMJE, 2023, p.3).

Multidisciplinary perspectives

Multidisciplinary teams are likely to have a variety of expectations because members bring with them disciplinary authorship conventions from their initial training and research experience(s). These conventions and the range of accepted practices are not always made explicit. As a result, collaborators may not realize that they do not share the same expectations regarding the nature and extent of contributions that warrant authorship versus those that only merit being mentioned in the acknowledgements section. In some fields, technical contributions such as those that involve using tools and equipment or writing code may be recognized with authorship, while in other disciplines, they may not even be mentioned in the acknowledgements section. In these contexts, the plurality of views about what constitutes an intellectual contribution, the challenge of using "intellectual contribution" to determine authorship status, and whether this concept should be used to determine authorship in the first place, are among the sources of tension (Smith, 2023).

One reason why this may be problematic is the ambiguity regarding what constitutes an "intellectual" contribution. Because there is no consensus about what it means for a contribution to be intellectual, different disciplines or groups might interpret this term differently, and perhaps, in so doing, create tensions in multidisciplinary projects where different types of contributions are made. In addition, there is the practical reality that some necessary contributions may be significant and substantial but not be considered intellectual. Examples mentioned in the literature include "burning prairies in spring/fall, as required in plant biology and restoration projects" (Hosseini et al., 2022b, p. 279) and conducting "hydrographic surveys to inform geological study of sedimentation" (Hosseini & Lewis, 2020, p. 89). Neither of these may be recognized as authorship-worthy contributions, especially if the contributor lacks higher educational degrees, direct engagement with the research proposal, or involvement in drafting or revising the manuscript.

Assumptions and overgeneralization

Students and trainees are likely to interpret their own experiences with authorship as representing common practice, if not a universal standard. It is therefore valuable for students and trainees to learn about authorship conventions in different contexts, disciplines, and circumstances, and discuss how authorship decisions are made and negotiated. Learning about different practices and nuances in seemingly similar situations will help researchers avoid mistaken assumptions and unreasonable/unrealistic expectations. Towards this end, Discussion of authorship with colleagues and friends from different research areas or at different career stages can be extremely helpful.[15]

Junior researchers are not the only ones to overgeneralize authorship practices. Members of a tenure and promotion committee at the same institution may assume that the significance of first authorship is the same for all candidates in all disciplines. Yet, for a particular publication with an alphabetical byline, the first author may be the first in the list of authors because 1) alphabetical was the disciplinary convention, 2) the team leader's preferred strategy was to list authors

[15] For example, during a group chat with chemistry students and plant biology postdoctoral associates all based at the same large university, one can learn that authorship order has nuances, Depending on the discipline or even the situation at hand, names in the byline might be ordered based on different conventions, including alphabetical, partially alphabetical (e.g., authors are listed alphabetically except for the first and last authors), or based on "who did the most work".

alphabetically, 3) listing authors alphabetically was the best solution to address a particular authorship dispute about who has done “the most work”, or 4) by coincidence, listing authors in order of who did “the most work” is also alphabetical. Policymakers and the public, too, may assume the first author knows the most about the work and the theories and literature upon which the work is based, while in fact, the most knowledgeable author may be the second author or the corresponding author who may (or may not) be listed last.

National and international issues

Depending on the discipline and research question, particular locations, personnel, resources (materials and equipment) and populations from different nations may be involved in research. The topic of “parachute” (or “helicopter”) science has received increasing attention over the last decade. The term refers to studies conducted in low- and middle-income countries (LMICs) by well-funded researchers based in high-income countries (HICs) who engage in little or no significant collaboration with (and acknowledgement of) local researchers, experts, or residents. This problem has been highlighted in diverse disciplines from global health (Abimbola, 2019; Cash-Gibson et al., 2018; Chersich et al., 2016; Kelaher et al., 2016; Morton et al., 2022; Rees et al., 2017) to ocean science, and paleontology to climate science (Gewin, 2023), and attempts have been made to address this (see, for example, TRUST, 2018). Parachute science raises concerns regarding the integrity of various phases of the research process including the identification and framing of the research question, research design, choice of methodologies, data selection and interpretation, and dissemination of results.

Economic disparities play a major role in parachute science, reflecting differences in the economic state of different countries and the extent to which scientific research is prioritized. HICs may have financial resources that enable them to promote awareness of problems of global importance (e.g., health and climate change), and to provide researchers with the support necessary to consider questions that might not be prioritized in LMICs, or the investigation of which might be perceived as too costly. Given the significance of funding acquisition in initiation of research projects, determining authorship, and project dynamics, researchers from HICs who have better access to financial resources, might feel entitled and, accordingly, offer no authorship, or a less prominent position in the byline, to those based in LMICs.

Parachute science highlights a failure to acknowledge and respect the invaluable contributions, experiences, and perspectives of local researchers. Individuals and populations who have lived experiences in a particular region provide perspectives unavailable to foreign or outside researchers. Local researchers are able to frame, examine, and approach problems in ways that consider local customs, flora, fauna, seasonal changes, and irregular events (e.g., local flooding) that may have an impact on how the research question is understood, what methods would be most useful, and how research findings might be presented to local populations and foreign audiences for a better understanding of investigated issues (Abimbola, 2019). Whatever the root cause (e.g., colonialism[16], ignorance or arrogance), lack of recognition of the local collaborators' skills, experiences, and perspectives, as well as inequity in available resources, can be perceived as a lack of respect. It should be noted that merely offering co-authorship to local researchers does not necessarily resolve the issue. In fact, this can exacerbate tensions and be seen as tokenism when, for example, one is included as a co-author but neither consulted, nor included in, major decisions about the research or publication (Gewin, 2023).

It is also important to note that collaborators based in different countries, or those based in different regions or institutions in the same country, could be in different socioeconomic circumstances. Different approaches to collaboration and authorship might reflect economic differences or deeply rooted limitations in the primary, secondary or higher education systems (e.g., lack of research equipment that results in limited hands-on research experience). While some researchers might have a range of advantages, including good wages and access to an array of necessary resources to conduct their research, this is not universally the case. Given such disparities, some researchers might feel compelled to agree with requests, or tolerate expectations that might be considered inappropriate or problematic. At the same time, such compromises might be the only way to ensure the collaboration can be suitably modified or continued. Being listed as an author in return for offering resources is an issue that was reported in many group discussions and involving both HICs and LMICs:

[16] Though parachute science is often perceived as a legacy of colonialism, it is not entirely a purely international concern. In many respects it is closely related to problematic research conducted on indigenous and other historically disadvantaged peoples by compatriots in their own country.

> "*In large collaborative projects both national and international, I've been forced to include as a co-author someone who does not know the work, [and) has not contributed anything other than access to resources. I accept this as a cost of getting access but do not agree [sic. approve).*"
>
> "*To get access to lab analysis without paying, the lab manager demanded to be on the paper. This was in a developing country. My co-author, a [nationality] had to agree.*"
>
> "*To be honest, too many experiences relate to the addition of authors at the last minute, students not being made aware that their work would be published with faculty as authors, authors being added to cover page charges, senior faculty demanding lead authorship when they didn't write the paper. Notably, these were less about issues with international collaboration but occurred within [affluent country], and the resolution was to just accept whatever unfairness occurs so that you can get at least some return back on your research effort.*"

Furthermore, some contributors might find it easier to work with those who speak the same language. This could be particularly challenging in international contexts where open discussions about all aspects of the work, including authorship, could be difficult for those who are working in a language other than one in which they are fluent, or comfortable.

Furthermore, dependency on visas and residence permits can create uncomfortable and precarious situations for international researchers living abroad. For instance, a researcher might not have the confidence to assert or advocate for themselves, or might easily yield to unfair demands for authorship, because of a fear that any push-back could jeopardize their temporary visa status or future employment opportunities.

Idiosyncrasies and individual differences

While there are no universally-accepted rules of authorship across all disciplines, there are conventions and increasingly common practices, some preferred or more favored than others. Further, as research has evolved over the last several decades, authorship practices continue to reflect the individual differences and idiosyncrasies of the primary-decision maker, that is, the head of a research group (who, at least initially, obtained funding, established a research team, and, over time, has largely determined the research direction of a group).

When it comes to authorship, some people are more inclusive than others. Some are more collegial, and some are relatively inflexible regarding their preferred criteria for authorship. Some supervisors are supportive of their students and trainees and make every effort to encourage promising young researchers. Such support and encouragement can include adding them to a byline when their contribution to that particular publication might not normally have been sufficient to grant authorship. This may be particularly apparent when junior researchers encounter unexpected obstacles[17] that impede and delay their research and interrupt progress to their degree and graduation, or production of publications that are critical to finding their first job.

Thesis advisors and research supervisors have a responsibility to ensure that students meet the institutional and departmental requirements for graduation, and that postdoctoral trainees are prepared to be independent researchers. This is sometimes taken to mean that everyone should be treated the same. However, some supervisors recognize a previous, uneven distribution of educational or other opportunities and advantages, and may seek to level the playing field to address inequities by weighting the same contribution type differently (for instance, data collection can lead to authorship for a student or trainee, but not for a technician) (Morton et al., 2022.). These choices by a supervisor may be perceived as unfair by some, especially if no explanation is provided (in some cases, the lack of an explanation could be due to privacy and confidentiality concerns).

Decisions about inclusion of co-authors are not always made by a single individual or based on the same criteria. Sometimes these decisions can become personal and subject to negotiations, meaning that contributors are likely to deal with interpersonal dynamics, misaligned expectations, and dissimilar commitments and motivations. Individuals may also have different working styles or different routines than those endorsed in a specific location or by a particular research supervisor. For example, some people are night owls and others are morning larks. Some people might need to follow religious diets (e.g., fasting during Ramadan) which might affect their daily routine and energy levels. Some live in countries that use a different calendar with different holidays and vacation times, which might have also instituted a Thursday-Friday or Friday-

[17] Some examples may include loss of samples due to natural disasters like hurricanes (Rodriguez et al. 2018) or a power outage (Oladipo, 2023) and various forms of accidental contamination of samples and drugs.

Saturday weekend instead of a Saturday-Sunday weekend. Some might be expecting a child, have children or a range of other caring responsibilities (e.g., caring for someone with a disability, sick parents or other relatives). In addition, health issues, safety and transportation concerns associated with working late, community obligations, and other personal and professional commitments and responsibilities can all affect, and be reflected in, one's working style, but they are not always communicated with everyone involved in a project. These differences may affect authorship by, rightly or wrongly, influencing perceptions of "who has done more work."

Poor communication

In the research setting (as in any workplace), miscommunication can lead to misunderstandings that can result in errors as well as incorrect assumptions and expectations. These may, rightly or wrongly, have an impact on authorship decisions. Furthermore, when conversations are spontaneous and informal (e.g., conducted in a hallway or elevator), or are particularly complex, or are full of new information, it is often the case that participants hear, attend to, focus on, and remember different elements of what was said, or remember the same elements differently. It is important to follow-up the conversation with a written memo or email identifying key ideas and information. This is particularly true when authorship is discussed, for example, as new researchers join the project or when the project takes a new turn. Some research groups circulate a draft list of authors among all co-authors periodically or whenever there is a change in personnel. This written document provides an opportunity (and potentially impetus) for discussion and clarification and can minimize confusion and misunderstanding as the work progresses.

In the early stages of a collaboration, the focus might be on the primary research activities and "getting the work done." Accordingly, authorship may be seen as both tangential, and as an issue that will resolve itself as the project proceeds (unless one or more of the researchers have had previous experience to the contrary). Further, communication about authorship can be difficult for many, including for senior researchers. These could all be among the reasons why authorship may not be addressed during the initial discussions about a research collaboration or before primary activities like data collection/analysis and writing. However, in omitting or delaying authorship discussions (not to be mistaken for making firm decisions about who should be an author and in what order—both of which are subject to changes throughout the process of

conducting research), researchers run the risk of exacerbating tensions. For example, those who are excluded after having completed a task (but prior to submission of a manuscript) might feel that they were teased with the promise of authorship but were denied at the last minute. Even in cases when authorship is discussed in the initial stages, a project might proceed in ways that do not align with agreed upon arrangements because, for example, motivations and priorities might change. Furthermore, within international projects, essential information about preferred authorship policies and applicable norms might not be communicated to all members of the research group (e.g., if this has been part of an initial conversation among the PIs).

All these factors can be confusing and lead to misunderstandings among students and trainees who may have little or no authorship experience, and team members who may have previously had experiences that differ significantly from those agreed upon in the current project. It is worthwhile to include authorship policies as one of the standard topics included in the orientation of new research group members, that is during the first day or week. In addition, periodic discussion of hypothetical authorship dilemmas and cases, perhaps over a laboratory meeting or lunch, will enhance understanding of the range of authorship issues. During these discussions, it is worthwhile to keep in mind that not everyone is clear and articulate in the spoken or written word. Furthermore, certain styles of communication and power differentials can be intimidating for some, whether intended or not. Accordingly, empathy, patience and encouragement are invaluable elements of effective communication.

Unpredictability of research

Science is unpredictable, and involves all kinds of unexpected changes, which can alter the course of a project and accordingly, expected contributions and anticipated requirements. While it is recommended that authorship be discussed in the early stages of a collaboration (Gadlin & Jessar, 2002), this does not always happen. Instead, team leaders may assume that appropriate authorship will become clear as the project develops and evolves. However, given that authorship can become a major source of tension and dissatisfaction, it is more effective to explicitly raise the topic early on, and then agree to revisit the subject on a regular basis. For example, collaborators could agree to discuss authorship in a particular time frame (e.g., every four months), or upon a particular development (e.g., whenever anyone leaves or joins the project).

When (experienced) researchers consider a particular question or hypothesis, and the kind of data that will be needed to address it, they generally know what expertise and methodologies will be required. They also have ideas about who among their research team members and colleagues could make specific contributions. This can be the beginning of a collaboration and collaborators may have only a vague idea of who else might be involved. As the collaboration develops and data are produced, the initial question or hypothesis is likely to be refined and perhaps expanded. New possibilities may become apparent as a result of unexpected findings and the project may take a new direction, or become two or more complementary but separate projects. Alternatively, because of unforeseen hurdles or challenges, initial expectations may not work out and some of the anticipated components of the project may be eliminated. New techniques may be introduced and new researchers with specific skills, or new graduate students, may be recruited to join the research group.

Moreover, depending on the (expected and actual) duration of a project, the success of the work, and the intervention of other professional and personal life events (e.g., graduation or illness), some members of the team may leave the project before completion, or before manuscript submission. In such instances, another individual, either from within or from outside the core team, might be recruited to complete pending tasks. Each of these situations adds to the complexity of a project and can alter both the initial role of team members, and assessment of the extent and significance of contributions to the project. This is likely to be reflected in authorship decisions in complicated ways.

In addition, when the project is written and submitted to a journal for publication, it is subjected to peer review. Reviewers may have various questions, requests, and concerns and, depending on their requests and editorial evaluations, further experimentation as well as writing may be necessary. This, too, can require adding new team members, and affect authorship decisions in unpredictable ways.

5. Recommendations to Avoid Confusion, Misunderstandings and Conflict

Communication, communication, communication

Clear communication among colleagues and team members can be key in preventing confusion, misunderstanding and conflict. The first step is to be clear with oneself regarding what needs to be communicated and why, that is, what information other members of the team must have in order for them to be functional and effective. This requires openness and transparency and involves making explicit that which may be implicit. Effective communication is also an iterative process requiring feedback to ensure that the intended message was actually conveyed and correctly understood. One way of minimizing miscommunication and misunderstanding is to consider potential differences in (or lack of) experience and knowledge that can lead to miscommunication. In international collaborations, language differences and fluency should always be considered as a factor that could contribute to miscommunication (Heitman, 2014).

Be inclusive and document decisions

It is critical to include all team members in early discussions about roles, contributions, and authorship criteria to minimize the likelihood of tensions and misunderstandings and foster an inclusive environment where all voices are heard and valued. It is equally important to document these discussions and share decisions with everyone involved. Authorship arrangements should be revisited and updated when appropriate, for instance, when research plans change, or members join or leave the research team.

Consider different perspectives

One's contribution is, like beauty, "in the eye of the beholder," and as previous research shows, contributors often overestimate their own contributions while underestimating that of others (Lissoni et al., 2013). Undergraduate students,, graduate students, and postdoctoral trainees should 1) be informed of the existence of disciplinary, institutional and international norms regarding authorship; 2) learn about common authorship conventions in research and the range of accepted practice in their specific field; 3) be informed of, and openly discuss, specific policies, practices, assumptions and expectations in their particular research group; and 4) be cognizant of intangible and/or invisible

contributions made by those who enable the project (be it through fieldwork, funding acquisition or provision of other resources).

For senior researchers, it is important to inform all group members, especially new trainees and students, about endorsed policies and authorship practices of the group. Both new and established members of the research group may be surprised to learn that some of the conventions, policies, and practices they have observed or learned from their earlier research experience are not universal.

Think about and reflect on what matters to you

Individuals should reflect on and explore authorship issues for themselves. Each researcher needs to develop a personal inventory of their own authorship practices and positive/negative experiences. Researchers should be clear about what authorship means to them, and what their non-negotiable principles are. This requires a careful and explicit reflection about their own expectations, assumptions, and, when appropriate, preferred policies about authorship, all of which need to be written down. Researchers should consider both the kind and the extent of contribution they believe merits authorship (and what does not), and what responsibility they believe authorship implies. Further, they should, as earlier recommended by Michael Zigmond [personal communication], review their own curriculum vitae and determine whether their publications mirror their now-articulated principles and values, and, if not, why not. Recognizing and understanding the basis for exceptions can be informative.

Address authorship as an evolving, subjective and multidimensional issue

General discussion about authorship involving all members of a research team should happen regularly (at least annually) and particularly whenever new members join the group.; It can be important for research team members to work collectively to reach agreement regarding how their norms and values are expressed in authorship practices (Plemmons et al., 2020). In addition, similar discussions could be the focus of a departmental seminar, where a panel of faculty or research team leaders from across various research groups present their authorship policies and explain their rationale in an interactive, open, and non-threatening fashion. This is important because it offers an opportunity for students and trainees (who may have relatively little experience with authorship) to hear concerns and perspectives of more experienced researchers.

Students and trainees need assistance in understanding the significance of authorship for the integrity of their work. In particular, they need to understand it in the context of their specific group or project, with explanations about authorship order, what authorship is and is not, why it matters and, sometimes, why it does not. They also need support in understanding and evaluating their assumptions and expectations. In addition, because authorship practices are evolving, established researchers also need to keep themselves up to date and reflect on these evolving norms in discussions with their colleagues and mentees. These discussions can perhaps be most effectively organized in peer group settings among colleagues when students, trainees and junior faculty can observe the range of views, assumptions and expectations of more senior, established researchers and faculty.

Whenever starting or joining a research collaboration, research team leaders should both ask potential collaborators to explicitly identify their expectations and assumptions regarding authorship, and state their own. This will assist in uncovering actual and potential conflicts and lay the foundation for future discussions as the project develops.

6. Points for Discussion

WITHIN YOUR RESEARCH GROUP	FOR COLLABORATORS
I. Authorship Discussions	
When during the research process does your group have conversations about authorship? ● Do you revisit the authorship discussion/conversation throughout the research process? ● If so, when (e.g., at the beginning of the process of drafting the manuscript; regularly, at defined periods, as in every three months) or why (e.g., there are unexpected research findings; a member is leaving/has left or someone new joins the project)?	When during the research process do you and your collaborating group have conversations about authorship? ● Do you revisit the authorship discussion/conversation throughout the research process? ● If so, when (e.g., at the beginning of the process of drafting the manuscript; regularly, at defined periods, as in every three months) or why (e.g., there are unexpected research findings; a member is leaving/has left or someone new joins the project)?
In the context of a research project, does your group discuss: ● Authorship attributions (expected contributions for consideration of authorship)? ● Authorship order (including any equal, “co-authorship” roles)? ● Expectations/responsibilities of authorship ● Practices or measures to ensure inclusion and equitability	Does your group share these specifics (attributions, order, responsibilities, etc.) with the collaborating group? ● If yes ,does your group initiate a joint conversation to discuss these issues collaboratively? ● If no, why not?

• Acknowledgments	
Who in the research group is involved in the decision making process regarding author attributions and authorship order? If only specific people are involved in the decision making, how is the entire group made aware of these decisions and/or any changes to those decisions?	Who in the collaborating group is involved in the decision making process regarding author attributions and authorship order? If only specific people are involved in the decision making, how is the entire group made aware of those decisions and/or any changes to these decisions?
Do you keep a record of each of these conversations/decisions, and share them with all involved contributors?	Do you keep a record of each of these conversations/decisions with your collaborating group and share them with all involved contributors?
Do you use formalized authorship agreements for each specific project?	Do you share your authorship agreement with collaborating groups? OR Do you jointly construct an authorship agreement for each collaboration?
II. Guidelines	
Does your group endorse an established, external set of authorship guidelines? • What are these guidelines? • Are all group members aware of the guidelines, and are new members informed about them as part of their orientation?	Does your collaborating group endorse an established, external set of authorship guidelines? • What are these guidelines? • If different from those endorsed by your team, who will discuss authorship with the collaborating group, when and how?

	● How are differences addressed?
Do the guidelines followed by your group convey specific information about authorship attribution author roles, or acknowledgement? ● Has the group made it clear what is meant by substantial or significant contribution in your research context? ● Do the guidelines encourage an open disclosure of contributions, for instance, using the CRediT model?	Is there alignment between the collaborating groups about criteria for authorship attribution? ● If different criteria are endorsed, who will discuss authorship with the collaborating group, when and how? ● How are differences addressed?
Does your group modify those guidelines for specific projects? ● If yes, why? Which aspects? When was the last time your group updated authorship guidelines? ● Was this a process that involved the entire research group, or was it a decision made by leadership?	When authorship guidelines are updated or modified, is the latest version or the rationale for changes communicated to the collaborators? ● If so, how? If not, why not?
Does your group have members from different disciplines with dissimilar authorship norms or expectations? ● How do you reconcile the differences?	Is your collaborating group in a different discipline with dissimilar practices, guidelines or expectations regarding authorship? ● How do you reconcile the differences?
Are group-specific authorship practices written down and accessible for all current and future	Are your group-specific authorship practices shared with collaborators? ● If yes, are these communicated

group members?	through open and inclusive conversations? ● If not, why not?
How and when do new members of the internal research group learn about the group's authorship practices?	How do new members of the collaborating research group learn about the authorship practices of the other, collaborating group?
III. Local and Context-specific Authorship Practices	
Does your group have usual practices (customs, habits) with regard to assigning authorship (for example, including thesis / dissertation committee members; including a lab head, supervisor, department chair, center director; taking a team approach and including all members of a research team regardless of exact contribution)? ● Are these customs considered common and/or generally accepted practice outside your research group, discipline, or country? ● What are possible consequences of not following a particular practice?	Is there alignment among the collaborating groups about accommodation of practices not universally or generally seen as acceptable?
How does your group address authorship attribution practices which may be regarded as questionable or (even) unacceptable (e.g., ghost authorship, gift	Does the collaborating group (and their institutions) share the same view about what is acceptable and what is not? If not, how do you reconcile the differences?

authorship, honorary authorship)?	
Does your research group use a contributorship approach (e.g., CRediT) to articulate contributions? ● Are the various possible categories of contribution agreed on in the research group?	Does your collaborating group use a contributorship approach (e.g., CRediT) to articulate contributions? ● Are the various possible categories of contribution agreed on by the collaborating group? ● What process is used to address disparities?
IV. Authorship order	
Does your group understand and agree on terminology for various author positions on the byline (e.g., first author, equal co-author, senior author, corresponding author)?	Does the collaborating group have the same or a different understanding of terminology and roles? If disparate, how do you reconcile the differences?
Does your group understand the various expectations and responsibilities that come with those roles?	Does the collaborating group have the same or a different understanding of author role expectations and responsibilities? If disparate, how do you reconcile the differences?
Does your research group differentially weight contributions to various components of the research process to determine author order?	Does the collaborating group differentially weight contributions to various components of the research process to determine author order? If disparate, how do you reconcile the differences?
Does your group have policies and procedures for:	Does the collaborating group have policies and procedures for:

· co-first authorship · co-corresponding authorship	· co-first authorship · co-corresponding authorship If disparate, how do you reconcile the differences?
V. Responsibility	
Does your group talk about responsibilities that co-occur with authorship credit? ● Does your group consider each author responsible only for their own contributions? Is there any discussion about collective responsibility and accountability for the manuscript as a whole?	Is there alignment among the collaborating groups regarding the attribution of responsibilities?
When an author is added as a co-author by (required) custom, what action (for example, read / comment critically; write a short synopsis of the manuscript; agree to be responsible for the contents) by that individual could ensure that the collaborating group is confident that that particular author can explain and defend the work?	When an author is added as a co-author by (required) custom, what action (for example, read/comment critically; write a short synopsis of the manuscript; agree to be responsible for the contents) by that individual could ensure that the collaborating group is confident that that particular author can explain and defend the work?
In the instance when contribution types are varied, and happen at different times, how does the group ensure that all authors 1) understand the objectives and methods used in the manuscript, 2) agree with its	In the instance when contribution types are varied, and happen at different times, how does the group ensure that all authors 1) understand the objectives and methods used in the manuscript, 2) agree with its

conclusions, and 3) can explain and defend the work?	conclusions, and 3) can explain and defend the work?
VI. Practices to ensure equitable inclusion	
Does your group have practices and processes to ensure that all researchers involved in the project (regardless of career stage, role or location) have opportunities to meaningfully contribute to and be informed about the project, for instance in overall research agenda, design, dissemination/conduct, management, analyses, interpretations, archiving, dissemination, and data sharing? ● Are those contributions recognized by an authorship attribution?	Have you worked together with your collaborating group on practices/processes to ensure that all researchers involved in the project (regardless of career stage, role or location) have opportunities to meaningfully contribute to and be informed about the project, for instance in overall research agenda, research design, dissemination/ conduct, management, analyses, interpretations, archiving, dissemination, and data sharing? ● In your collaborating group, are those contributions recognized by an authorship attribution?
Does your group have any guidelines for including undergraduates, trainees, technicians, or early career researchers as co-authors? Are there specific criteria for including these individuals?	Does the collaborating group have its own guidelines for inclusion of undergraduates, trainees, technicians, or early career researchers as co-authors? If disparate, how do you reconcile the differences?
Does your group have a process or practice of acknowledging any power differentials, personal circumstances or privileged positions among members of the project? ● To the extent possible, are these	Is the collaborating group operating in a different country? ● If yes, are you aware of their circumstances (e.g., socioeconomic environment, safety and security issues)?

openly shared? ● How do you ensure that differences are tolerated and used to the group's benefit?	● In case members of the collaborating team do not speak the same language as members of your team, how do you ensure effective communication?
When some members of the research team are based in an LMIC and their contributions are comparable, how does your team ensure that they are appropriately recognized for their contributions? ● Are they involved in discussions about authorship?	When the collaborating group is based in an LMIC, how does your team ensure that researchers from that LMIC are appropriately recognized for their contributions? ● Are they involved in discussions about authorship?
VII. Dispute Resolution	
What is the process for resolving authorship disagreements? ● Who is initially involved in attempts to resolve the issue? ● Is there a process for escalation? ● Who is the final arbiter?	Does the collaborating team have a process for resolving disagreements? If disparate, where can there be alignment? OR Do you work out a resolution process with your collaborating group?
Are there available/accessible resources (for instance, an Ombuds office) to assist with any necessary mediation?	Does the collaborating group have access to resources to assist with any necessary mediation? If yes, is there a process in place to connect the two resources to work together? If not, is there a way to connect the collaborators to the resources housed elsewhere?

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