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Authorship climate: A new tool for studying ethical issues in authorship

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ABSTRACT

Authorship of academic publications is central to scientists' careers, but decisions about how to include and order authors on publications are often fraught with difficult ethical issues. To better understand scholars' experiences with authorship, we developed a novel concept, *authorship climate*, which assesses perceptions of the procedural, informational, and distributive justice associated with authorship decisions. We conducted a representative survey of more than 3,000 doctoral students, postdoctoral researchers, and assistant professors from a stratified random sample of U.S. biology, economics, physics, and psychology departments. We found that individuals who tend to have more power on science teams perceived authorship climate to be more positive than those who tend to have less power. Alphabetical approaches for assigning authorship were associated with higher perceptions of procedural justice and informational justice but lower perceptions of distributive justice. Individuals with more marginalized identities also tended to perceive authorship climate more negatively than those with no marginalized identities. These results illustrate how the concept of authorship climate can facilitate enhanced understanding of early-career scholars' authorship experiences, and they highlight potential steps that can be taken to promote more positive authorship experiences for scholars of all identities.

KEYWORDS

Authorship; empirical studies of research ethics; publication ethics; authorship climate; organizational justice; organizational and institutional ethics; diversity; equity; inclusion in science

Introduction

Although authorship of academic publications is central to scientists' careers (Smith et al. 2019a; Wager 2009), it is fraught with ethical decisions

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and concerns (Hosseini and Gordijn 2020). Many of these ethical concerns involve difficulties determining how to appropriately assign and order the authors on scientific papers (e.g., Marušić, Bošnjak, and Jerončić 2011; Kaufmann et al. 2010; Smith et al. 2019b), and this task has become even more difficult as scientific teams have increased in size and interdisciplinarity (Hall et al. 2018). Some disciplines, such as economics, typically order authors on papers alphabetically, whereas other disciplines, such as psychology, typically order authors by contribution. Although ordering authors by contribution might seem to be a fairer approach, it also creates the potential for confusion, miscommunication, and disagreement. For example, a survey of more than 6000 recently-published authors found that 46.6% reported disagreements about the ordering of authors on scientific papers (Smith et al. 2019b). Ambiguities surrounding authorship decisions contribute to widespread incidences of honorary authorship (i.e., inclusion of authors who did not actually meet criteria for authorship) and ghost authorship (i.e., failure to include individuals who did meet criteria for authorship; see e.g., Kennedy, Barnsteiner, and Daly 2014; Kornhaber, McLean, and Baber 2015). Qualitative studies provide further evidence that authorship decision-making often stretches the limits of the guidance provided by official authorship policies and can generate conflict and confusion on science teams (Birnholtz 2006; Elliott et al. 2017; Louis et al. 2008; Settles et al. 2018).

Difficulties associated with assigning and ordering authors can also be damaging to scientific teams and detract from the scientific community's efforts to foster diversity, equity, and inclusion. Scholarship has indicated that scientific teams are often poorly equipped to deal with authorship conflicts, and as a result they sometimes avoid difficult authorship decisions by including all team members as authors on papers (Elliott et al. 2017). Although such activities might appear to be "inclusive," they can detract from the credit deserved by those who made significant contributions (Settles et al. 2018). This is especially problematic given evidence that research teams and those reading the teams' publications may undervalue the contributions made by women authors and the quality of their work relative to that of authors who are men (Knobloch-Westerwick, Glynn, and Huge 2013; Ross et al. 2022; Sarsons 2017). There is also evidence that women may be underrepresented in the most prestigious (e.g., first- and last-author) positions on scientific papers (Fishman et al. 2017; Pico et al. 2020; West et al. 2013), and this problem may be exacerbated by the ambiguities involved in making authorship decisions. Although little research has been done on the authorship experiences of other underrepresented and marginalized groups in the sciences, they likely experience similar difficulties.

To address these authorship challenges, a combination of structural solutions (dealing with policies and procedures) and cultural solutions (involving

values and norms) will likely be needed (Elliott et al. 2017). Important structural solutions for addressing these challenges include efforts to clarify criteria for authorship, to specify the roles that each author played in publications, and to develop authorship policies and procedures for science teams (Greenland and Fontanarosa 2012; Oliver et al. 2018; Weltzin et al. 2006). Cultural solutions have received less attention in the literature about authorship, but they could include efforts to foster greater trust, fewer power differentials, and better conflict-management skills on science teams (Cheruvelil et al. 2014). Both structural and cultural solutions can alter the climate (i.e., norms, attitudes, and expectations) in science. Previous scholarship indicates that the climate on science teams is associated with team members' satisfaction with authorship practices and that climate perceptions may serve as a mediating factor that contributes to lower satisfaction with team authorship practices for those from underrepresented and marginalized groups (Settles et al. 2019). For example, Cech et al. (2021) found that lesbian, gay, bisexual, transgender, and queer (LGBTQ) scientists were less likely than their cisgender-heterosexual peers to experience positive team climates, and this contributed to more negative authorship experiences for the LGBTQ scientists. This research suggests that science teams might be able to generate more fruitful discussions about authorship decisions and achieve greater equity and genuine inclusivity in their authorship practices by fostering more positive team climates.

In order to guide future scholarship on the role that climate plays in authorship practices and experiences, we introduce a novel concept, *authorship climate*, defined as perceptions of the fairness of processes, fairness of communication, and fairness of outcomes related to authorship of scientific work. Each of these elements (processes, communication, and outcomes) are important aspects of ethical authorship decision making, and they correspond to important aspects of justice more broadly (e.g., Beauchamp and Childress 2001; Colquitt 2012). In order to engage in responsible authorship decision making, it is ethically important that the *processes* leading to decisions about who will be an author on a paper and how those authors will be ordered are fair. For example, there should be clear standards for identifying those who have made sufficient contributions to count as authors and for deciding where they should appear in the authorship list (Feeser and Simon 2008; Shamoo and Resnik 2015). It is also ethically important to have clear and honest *communication* about why authorship decisions were made in particular ways. For example, those who did not appear as authors or those who appeared in less prominent positions on the authorship list should understand the basis for those decisions. Finally, the authorship list should give *appropriate credit* to those who made significant contributions to a paper because the proper allocation of credit is one of the most important ethical norms of scientific research (Resnik 1998; Shamoo and Resnik 2015).

These ethical considerations are especially crucial given the prominent role that authorship on scientific papers plays for scientists' careers.

To measure our concept of authorship climate, we propose using an adaptation of Colquitt's framework of organizational justice (Colquitt 2012). Colquitt's framework is well-suited for this purpose because it is designed to measure an individual's perception of their organization (e.g., workplace) as fair. It is a multidimensional construct that measures different aspects of decision-making. Three of the dimensions in Colquitt's framework (2012) correspond to the three elements of authorship climate: *procedural justice* refers to individuals' sense of fairness and voice in the processes and procedures around how decisions are made, *informational justice* refers to the extent to which individuals feel that information related to the decision is justified and communicated honestly, and *distributive justice* refers to individuals' perceptions of fairness in the outcome of the decision relative to their contribution. Thus, we propose that the fairness of the processes, communication, and outcomes associated with authorship decisions can be measured by adapting Colquitt's (2012) measures for procedural justice, informational justice, and distributive justice, respectively. Our concept of authorship climate extends previous research on the relationships between team climate and authorship (e.g., Cech et al. 2021; Settles et al. 2019) by incorporating these three major ethical aspects of authorship decision-making.

Given the existing evidence that the overall team climate can affect satisfaction with authorship practices (Settles et al. 2019), we propose that one of the major strengths of studying authorship climate is gaining further insight into the academic experiences of early-career scholars, especially those from marginalized groups. For individuals from marginalized groups, who already experience identity-based discrimination, unjust authorship decisions may create another form of exclusion (Settles et al. 2018). Some prior research suggests that the relationships between organizational justice and demographic characteristics, including gender, race, and age, although small, are statistically significant and potentially contribute to exclusion of marginalized groups (Cohen-Charash and Spector, 2001). Given the importance of publishing and the existing equity-barriers in publishing for scholars from marginalized groups (Bendels et al. 2018; Fishman et al. 2017; West et al. 2013), there might also be an important relationship between authorship climate and these demographic characteristics. If so, such relationships might highlight ways in which authorship practices contribute to persistent barriers to diversity in higher education.

Overview of the current study

In the current study, we propose a novel concept, authorship climate, and explore how perceptions of authorship climate vary across academic characteristics (i.e., academic field and career stage), authorship practices (author order and determination method), and marginalized identity status. Specifically, we examine three research questions: (1) Do scholar perceptions of authorship climate differ based on their career stage and academic field? (2) Do scholar perceptions of authorship climate differ based on author order and authorship determination method? and (3) Do scholars from marginalized groups perceive the authorship climate more negatively than authors from more privileged groups? We examine these research questions in a sample of academics from a variety of PhD-granting U.S. institutions, across different career stages (doctoral students, postdoctoral researchers, and assistant professors), and across four academic fields (biology, physics, economics, and psychology).

In academia, publishing remains one of the primary tools for career advancement (Pinheiro, Melkers, and Youtie 2014; Sherif, Nan, and Brice 2020). As such, ethical authorship practices are imperative to ensure that every individual has the opportunity to attain success in academia. In order to promote diversity in the academy, it is important to make sure that marginalized groups have equitable publishing opportunities relative to academics from priviliged groups and feel like they are able to succeed. If some scholars, especially those from marginalized groups, feel less positive about authorship procedures, communication about authorship decisions, and the outcomes of those procedures and decisions, this may reflect inequities in the authorship opportunities available to them and discourage them about their potential to excel. Thus, authorship climate may be a crucial missing link for understanding the climate perceptions and turnover intentions of academics, including those from marginalized groups.

Method

Participants and procedure

We conducted a representative survey of doctoral students, postdoctoral researchers, and assistant professors from a stratified random sample of 124 departments of biology, economics, physics, and psychology from 94 different U.S. institutions. The survey was distributed via e-mail between April and May 2021 through the Qualtrics platform. Each participant received a unique link to ensure they could not take the survey multiple times. Participants received an initial recruitment e-mail, and three reminder e-mails were sent to all who had not yet completed the survey. Of the 10,658 persons contacted, we received 3,531 responses (33.1% response rate). Within this sample, 63 participants were no longer in the department

from which they were recruited, but we retained them as they remained in our target population (i.e., doctoral student, postdoctoral researcher, or assistant professor in biology, economics, physics, or psychology). The online questionnaire consisted of demographic questions and measures related to well-being, academic job outcomes, academic climate, and productivity. The questionnaire took approximately 30 minutes to complete, and participants received either a USD $35.00, $25.00, or $20.00 check depending on the survey completion date. All participants provided informed consent prior to their participation. Survey procedures were approved and deemed exempt from continuing review by the institutional review boards at both the University of Michigan (HUM00193386) and Michigan State University (STUDY00004853).

As we were interested in experiences of authorship collaborations, participants were included in the analyses if they completed at least those questions included in authorship analyses (55% of the survey) and reported that they had been involved in a coauthored manuscript (N = 2,564). The majority of respondents were doctoral students (78.2%; n = 2,005); 12.7% were postdoctoral scholars (n = 326), and 9.1% were assistant professors (n = 233). Of our participants, 27.1% were in biology (n = 696), 14.7% were in economics (n = 378), 26.6% were in physics (n = 681), and 31.6% were in psychology (n = 809). In this sample, 28.6% identified as Asian or Asian American (n = 733), 3.6% identified as Black or African American (n = 93), 9.4% identified as Hispanic or Latin(a/o/x) (n = 240), 3.4% identified as Middle Eastern or North African (n = 86), 0.8% identified as Native American or American Indian (n = 21), 62.9% identified as White (n = 1,613), and 1.8% of participants declined to self-identify their race/ethnicity (n = 45). Note that participants were instructed to select all that apply for their race/ethnicity; therefore, the total percentages are greater than 100%. Participants self-identified their gender as woman (49.5%; n = 1,270), man (47.4%, n = 1,215), or genderqueer or gender non-binary (2.0%, n = 51); 1.1% of participants declined to self-identify their gender (n = 28).

Measures

For all of the authorship measures used in the study, participants were asked to think about one recent manuscript that was typical of their collaborating experiences. They then responded to a number of questions about their authorship experiences on that manuscript. Instructions before each measure reminded them to "think about the same co-authored manuscript that you previously described."

Author order

We assessed the author order using a single item that asked, "Are you the lead author on this manuscript (i.e., the person who was responsible for drafting the largest portion of the paper)?" Participants responded yes (1) or no (2).

Authorship determination method

Authorship determination method was assessed with a single item that read, "How was the author order on this manuscript determined?" Participants could respond to three close-ended options or write in another authorship determination method. Responses were categorized as: (1) alphabetical; (2) by contribution; or (3) a hybrid of alphabetical and contribution (hereafter, "hybrid"). Hybrid authorship included situations when authorship was determined by contribution for first author(s) and alphabetically for other coauthors; sometimes this hybrid determination also included the principal investigator (PI) being listed as last author.

Authorship climate

We assessed three dimensions of authorship climate, drawing on Colquitt's (2001) Organizational Justice measure: authorship procedural justice climate, authorship informational justice climate, and authorship distributive justice climate *(see Appendix for a list of all items)*. For all subscales, participants indicated their agreement with each item on a scale from 1 *(not at all)* to 5 *(completely)*. We computed a mean score for the measure such that higher scores indicated greater perceptions of each type of authorship climate (Table 1).

Procedural justice in the context of authorship climate was assessed using an adapted version of the procedural justice subscale (Colquitt 2001). The adapted measure consists of six items assessing how much influence an individual believed they had over authorship decisions and whether the processes were fair. Five of the items in the authorship procedural justice climate subscale were adapted from Colquitt's original items by wording questions to be about authorship (e.g., "Were authorship practices free of bias") and one of the items was created for the study (e.g., "Was everyone involved in the project given the opportunity to earn authorship on the

Table 1. Means (*M*), standard deviations (*SD*), sample size (*N*), and correlations (*r*s are listed in columns 1 and 2) for each authorship climate subscale.

	M	*SD*	*N*	1	2
1. Procedural justice	3.6	1.0	2,533		
2. Informational justice	3.4	1.3	2,497	.66***	
3. Distributive justice	4.1	1.0	2,509	.52***	.37***

*** denotes $p < .001$.

manuscript?"). Reliability analysis yielded a Cronbach's alpha of .84, which compares favorably to Colquitt's (2001) alpha of .78 in the original study.

Informational justice in the context of authorship climate was measured using an adapted version of Colquitt's (2001) informational justice subscale. The measure consisted of three items examining how well the lead author communicated expectations, tasks, and procedures related to authorship on the manuscript in a way that facilitated inclusion. Two of the items were adapted from Colquitt's informational justice subscale by referencing authorship communication (e.g., "Were people in your co-authorship candid in their communications about how authorship was determined?") and one item was created for the study ("Were all co-authors included in conversations about authorship?"). Reliability analysis found a Cronbach's alpha of .89, which is similar to Colquitt's (2001) alpha of .79 in the original study.

Distributive justice in the context of authorship climate was measured to determine how well authorship outcomes reflected contributions to the manuscript. We used three items adapted from Colquitt's (2001) distributive justice subscale (e.g., "Did your author position reflect the effort you put into the publication?") and one item that we developed (i.e., "Did your author position reflect what you contributed to the publication?"). Reliability analysis found a Cronbach's alpha of .90, which is very similar to Colquitt's (2001) alpha of .92 in the original study.

Marginalized identities

We created a composite variable that was a count of the number of marginalized identities a participant held along seven dimensions: woman or non-binary gender, transgender identity, person of color (i.e., Asian or Asian American, Black or African American, Hispanic or Latin(a/o/x), Middle Eastern or North African, Native American or American Indian, multiracial/multiethnic), sexual minority (i.e., lesbian, gay, bisexual, pansexual), at least one disability (i.e., physical, mental, or learning disability), first generation college student, and born outside the U.S. Participants who reported two or more marginalized identities (n = 1,787) were grouped together for analysis and compared to those who self-reported one marginalized identity (n = 555) and those who self-reported no marginalized identities (n = 222). In our sample, the most common marginalized identities were based on gender (n = 1,321 women or non-binary/genderqueer), race (n = 1,127 Black, Indigenous, people of color), and disability status (n = 1,145 with a physical, mental, or learning disability).

Analytic plan

For each research question, we conducted factorial ANOVAs to assess how academic characteristics, authorship practices, and marginalization related to

different experiences of the three dimensions of authorship climate: *procedural justice, informational justice*, and *distributive justice*. For all post hoc and simple effects analyses, we used a Bonferroni adjusted *p*-value. All analyses were conducted using STATA 16 software.

Results

Means, standard deviations, and correlations among the three authorship climate variables are presented in Table 1. An examination of the means indicates that authorship climate was moderately positive, with average responses on all three climate scales above the midpoint ("a moderate amount"). Further, all three climate scales were moderately correlated (*r*s = .37 – .66) with each other.

Our first research question relates to how *academic characteristics*, specifically career stage and academic field, affect authorship climate (Table 2). Results of three separate 3 × 4 between-subjects ANOVAs (career stage: doctoral students, postdoctoral researchers, or assistant professors x academic field: biology, economics, physics, or psychology, respectively) indicated a main effect of career stage for all three authorship climate dimensions – procedural justice ($F(2, 2521) = 67.93$, $p < 0.001$, $\eta_p^2 = 0.05$), informational justice ($F(2, 2485) = 17.48$, $p < 0.001$, $\eta_p^2 = 0.01$), and distributive justice ($F(2, 2497) = 9.88$, $p < 0.001$, $\eta_p^2 = 0.01$). Across all three dimensions of authorship justice, assistant professors experienced the authorship climate as more just compared to doctoral students and postdoctoral researchers (all *p*'s < 0.001), who

Table 2. Means (*M*) and standard deviations (*SD*) of procedural justice, informational justice, and distributive justice by the academic characteristics of career stage and academic field.

	Doctoral Student *M* (*SD*)	Postdoctoral Researcher *M* (*SD*)	Assistant Professor *M* (*SD*)	*Total by Field M* (*SD*)
Procedural Justice				
Biology	3.5 (1.0)	3.7 (0.9)	4.3 (0.7)	3.6 (1.0)
Economics	3.6 (1.0)	3.5 (1.4)	4.3 (0.8)	3.7 (1.0)
Physics	3.5 (0.9)	3.8 (0.9)	4.2 (0.9)	3.6 (0.9)
Psychology	3.5 (1.0)	3.9 (0.9)	4.4 (0.5)	3.6 (1.0)
Total by Career Stage	3.5 (0.9)	3.8 (0.9)	4.3 (0.7)	
Informational Justice				
Biology	3.3 (1.3)	3.4 (1.2)	3.8 (1.0)	3.4 (1.3)
Economics	3.6 (1.3)	3.5 (1.4)	4.4 (1.0)	3.7 (1.3)
Physics	3.4 (1.2)	3.5 (1.1)	3.7 (1.0)	3.4 (1.2)
Psychology	3.3 (1.3)	3.5 (1.2)	3.9 (1.0)	3.4 (1.3)
Total	3.4 (1.3)	3.4 (1.2)	3.9 (1.0)	
Distributive Justice				
Biology	4.3 (0.8)	4.3 (0.7)	4.6 (0.5)	4.3 (0.8)
Economics	3.8 (1.2)	3.4 (1.6)	4.1 (1.1)	3.8 (1.2)
Physics	4.0 (1.1)	3.9 (1.2)	4.2 (1.0)	4.0 (1.1)
Psychology	4.2 (0.9)	4.5 (0.6)	4.6 (0.5)	4.3 (0.8)
Total	4.1 (1.0)	4.2 (0.9)	4.4 (0.8)	

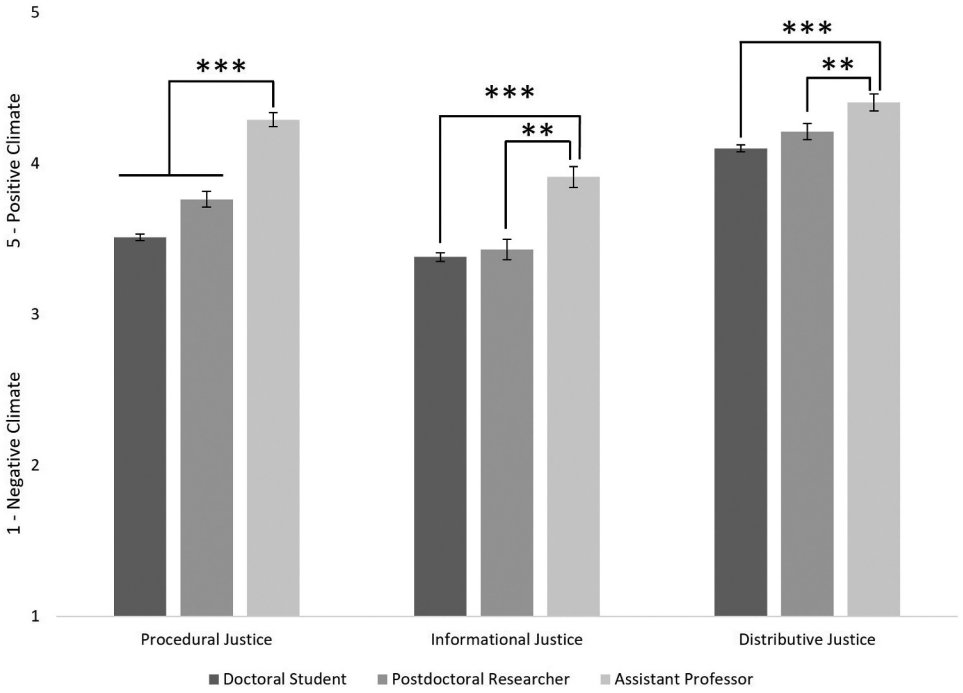

Figure 1. Mean authorship climate experiences of procedural justice (left), informational justice (middle), and distributive justice (right) by the main effects of career stage. Error bars represent standard error of the mean. ** $p < .01$ *** $p < .001$.

did not differ from each other (Figure 1). There were also differences in authorship distributive justice by academic field ($F(3, 2497) = 16.64$, $p < 0.001$, $\eta_p^2 = 0.02$; Figure 2). Specifically, scholars in economics and physics reported a significantly worse climate of distributive justice compared to biology and psychology scholars (all p's < 0.001), though the fields in each pair (economics and physics, biology and psychology) did not differ significantly from each other. Finally, there was no career stage by academic field interaction for any measure of authorship climate (all $F < 1.5$, p's > 0.173).

Our second research question asks how *authorship practices* on a specific manuscript, namely author order and authorship determination method, affected authorship climate perceptions (Table 3). We examined this question by conducting three separate 2 × 3 between-subjects ANOVAs (author order: lead author or non-lead author x authorship determination method: alphabetically, by contribution, or hybrid). We found that lead authors ($n = 1{,}265$) reported more positive procedural ($F(1, 2356) = 42.01$, $p < 0.001$, $\eta_p^2 = 0.02$), informational ($F(1, 2321) = 9.72$, $p = 0.002$, $\eta_p^2 = 0.004$), and distributive ($F(1, 2334) = 16.91$, $p < 0.001$, $\eta_p^2 = 0.01$) authorship climate than non-lead authors ($n = 1{,}076$; Figure 3). Further, we found that authorship determination method affected all three authorship climate measures (Figure 4).

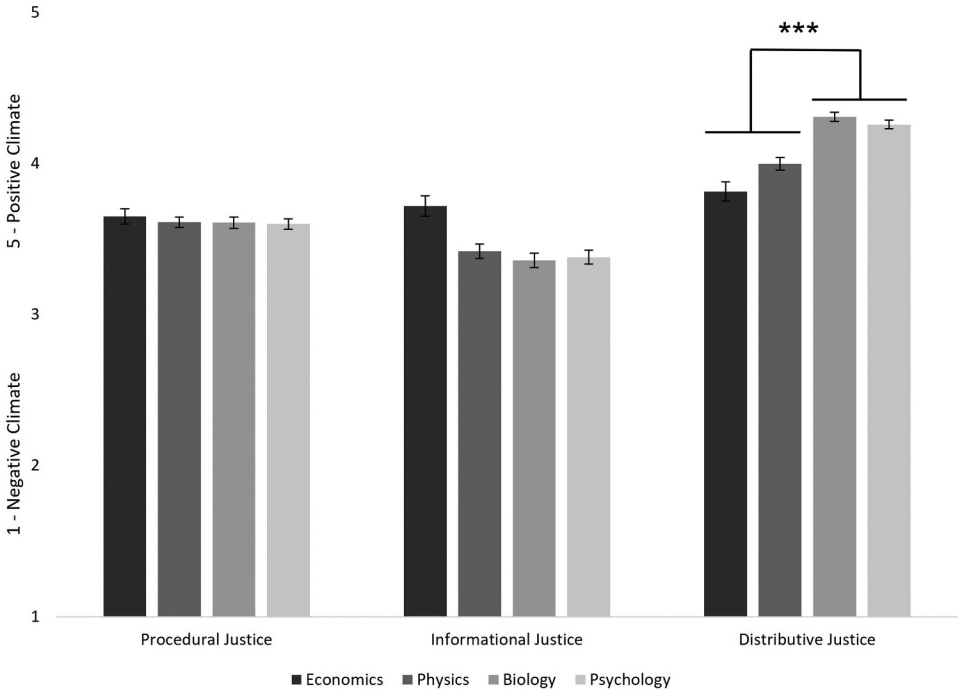

Figure 2. Mean authorship climate experiences of procedural justice (left), informational justice (middle), and distributive justice (right) by the main effects of academic field. Error bars represent standard error of the mean. *** $p < .001$.

Table 3. Means (*M*) and standard deviations (*SD*) of procedural justice, informational justice, and distributive justice by the authorship practices of authorship order and authorship determination method.

	Alphabetically *M* (*SD*)	By Contribution *M* (*SD*)	Hybrid *M* (*SD*)	*Total M* (*SD*)
Procedural Justice				
Lead Author	3.7 (0.9)*	3.9 (0.9)***	3.6 (1.0)**	3.8 (0.9)
Not Lead Author	3.6 (0.9)*	3.4 (0.9)***	3.3 (0.9)**	3.4 (0.9)
Total	3.6 (0.9)	3.7 (0.9)	3.5 (1.0)	
Informational Justice				
Lead Author	3.9 (1.3)	3.6 (1.2)	3.4 (1.2)	3.6 (1.2)
Not Lead Author	3.7 (1.2)	3.2 (1.3)	3.2 (1.3)	3.3 (1.3)
Total	3.8 (1.3)	3.4 (1.2)	3.3 (1.2)	
Distributive Justice				
Lead Author	3.6 (1.4)	4.5 (0.6)***	4.2 (0.7)	4.3 (0.8)
Not Lead Author	3.6 (1.3)	4.1 (0.9)***	4.0 (0.9)	3.9 (1.0)
Total	3.6 (1.4)	4.3 (0.8)	4.1 (0.8)	

Asterisks denote the pattern of results for the significant interactions between authorship order and authorship determination method for procedural justice and distributive justice. The significance is indicated between lead authors and not lead authors within the three authorship determination methods. * $p < .05$; ** $p < .01$; *** $p < .001$.

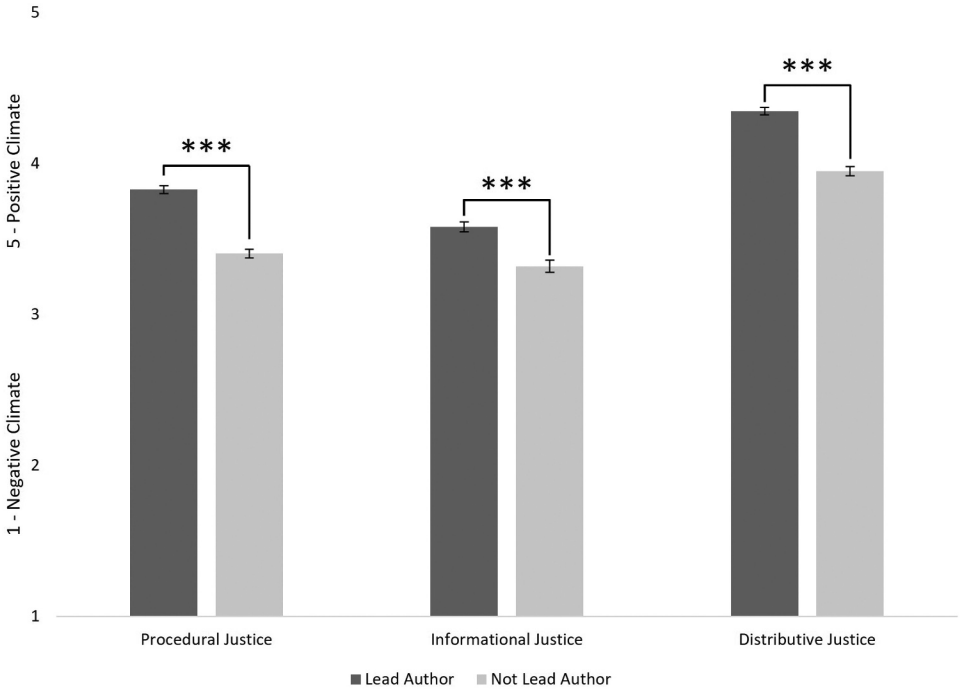

Figure 3. Mean authorship climate experiences of procedural justice (left), informational justice (middle), and distributive justice (right) by the main effects of authorship order. Error bars represent standard error of the mean. *** $p < .001$.

Specifically, when manuscript authorship was determined alphabetically or by contribution, participants reported more procedural justice ($F(2, 2356) = 3.65$, $p = 0.026$, $\eta_p^2 = 0.003$) than when authorship was determined using a hybrid method. Participants experienced more informational justice ($F(2, 2321) = 18.86$, $p < 0.001$ $\eta_p^2 = 0.02$) when authorship was determined alphabetically than when it was determined by contribution or by hybrid method (all p's < 0.001). Distributive justice climate ($F(2, 2335) = 73.00$, $p < 0.001$ $\eta_p^2 = 0.06$) was more positive when authorship was determined by contribution or using a hybrid method compared to when it was determined alphabetically (all p's < 0.001).

There were interactions between authorship order and authorship determination method for procedural ($F(2, 2356) = 5.09$, $p = 0.006$, $\eta_p^2 = 0.004$) and distributive ($F(2, 2335) = 10.91$, $p < 0.001$, $\eta_p^2 = 0.01$) authorship climate (Table 3). Specifically, when authorship was determined by contribution or using a hybrid method, lead authors reported greater procedural justice compared to non-lead authors; lead authors and non-lead authors did not differ in procedural justice when authorship was determined alphabetically. When authorship was determined by contribution, lead authors reported significantly greater distributive justice compared to non-lead authors; lead

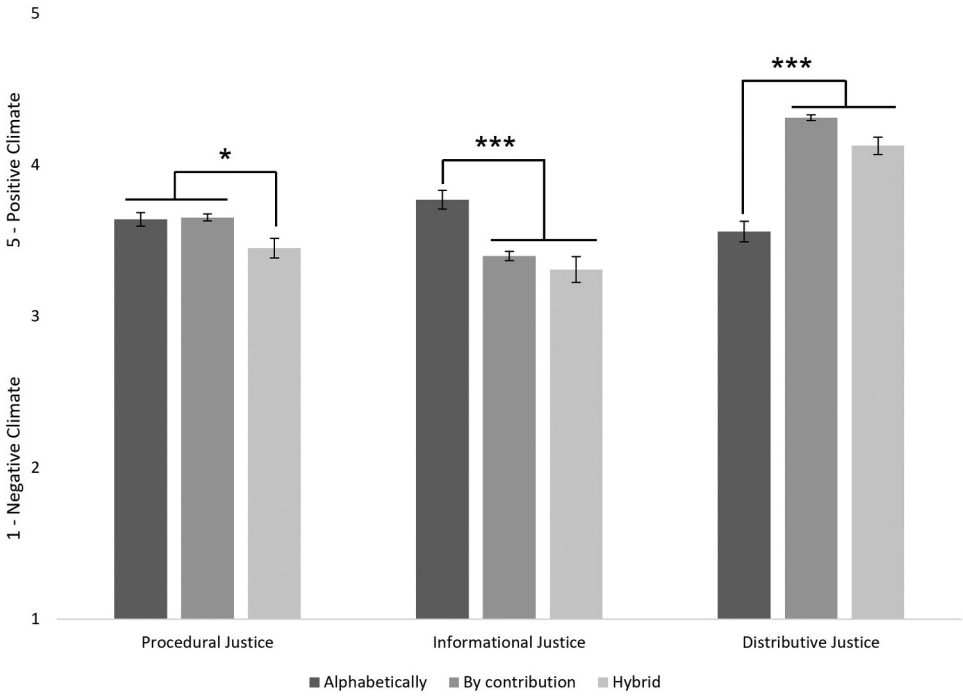

Figure 4. Mean authorship climate experiences of procedural justice (left), informational justice (middle), and distributive justice (right) by the main effects of authorship determination method. Error bars represent standard error of the mean. * $p < .05$; *** $p < .001$.

and non-lead authors did not differ when authorship was determined alphabetically or using a hybrid method. Follow-up examination indicated that academic field differences in authorship determination practices may have accounted for some of the differences we found in distributive justice by field (Table 4, Figure 2). In particular, economics and physics—fields where alphabetical authorship determination is the norm—were those with the lowest distributive justice climate experiences.

Our third research question asks whether scholars from marginalized groups perceive the authorship climate more negatively than those from more privileged groups. Results of three separate one-way ANOVAs

Table 4. Number of authorship determination methods reported for each of the four academic fields.

	Biology	Economics	Physics	Psychology
Alphabetically	17 (2.6%)	279 (77.9%)	130 (20.0%)	2 (0.3%)
By Contribution	554 (84.5%)	68 (19.0%)	421 (64.8%)	715 (96.2%)
Contribution-Alphabetical Hybrid	85 (13.0%)	11 (3.1%)	99 (15.2%)	26 (3.5%)
Total	656	358	650	743

Percentages refer to the percent of each authorship determination method reported within each field.

Table 5. Means (*M*) and standard deviations (*SD*) of procedural justice, informational justice, and distributive justice for scholars with marginalized identities (i.e., 2 or more (2+) marginalized identities, 1 marginalized identity, no marginalized identities).

Effect	No Marginalized Identities *M* (*SD*)	1 Marginalized Identity *M* (*SD*)	2+ Marginalized Identities *M* (*SD*)
Procedural Justice	3.9 (0.9)	3.7 (0.9)	3.5 (1.0)
Informational Justice	3.7 (1.2)	3.5 (1.2)	3.4 (1.3)
Distributive Justice	4.3 (1.0)	4.2 (1.0)	4.1 (1.0)

(marginalized identities: none, one, two or more) that controlled for career stage and field indicated that scholars with marginalized identities had significantly different experiences of procedural ($F(2, 2525) = 16.63$, $p < 0.001$, $\eta_p^2 = 0.01$), informational ($F(2, 2489) = 7.54$, $p < 0.001$, $\eta_p^2 = 0.01$), and distributive ($F(2, 2501) = 8.79$, $p < 0.001$, $\eta_p^2 = 0.01$) authorship climate (Table 5). Post hoc analyses demonstrated that scholars with two or more marginalized identities reported less positive procedural authorship climate compared to those with no or one marginalized identity, and less informational and distributive authorship climate compared to those with no marginalized identities (Figure 5).

Discussion

In this paper, we present and study a new aspect of the climate in science teams, namely, *authorship climate*. We examine how academic characteristics and authorship practices affect authorship climate, as well as how scholars from marginalized groups perceive authorship climate. Our study highlights important aspects of authorship climate (i.e., procedural justice, informational justice, distributive justice) that merit further investigation. Our findings also increase understanding about the academic experiences of early-career scholars, especially those from marginalized groups. Below we discuss the implications of these results and propose strategies to promote ethical authorship practices for collaborative writing.

Our results point to the important role of power in authorship practices. For example, we found that graduate students and postdoctoral researchers reported worse authorship climate than assistant professors on all three dimensions that we examined: procedural, informational, and distributive justice. We also found that lead authors reported a more positive authorship climate on all three dimensions. Both results may be related to the greater power that assistant professors and lead authors, respectively, tend to have on research teams. Interestingly, assistant professors and lead authors may not realize their relative power (e.g., in assigning authors) and how that affects authorship climate. Our findings documenting the connections between

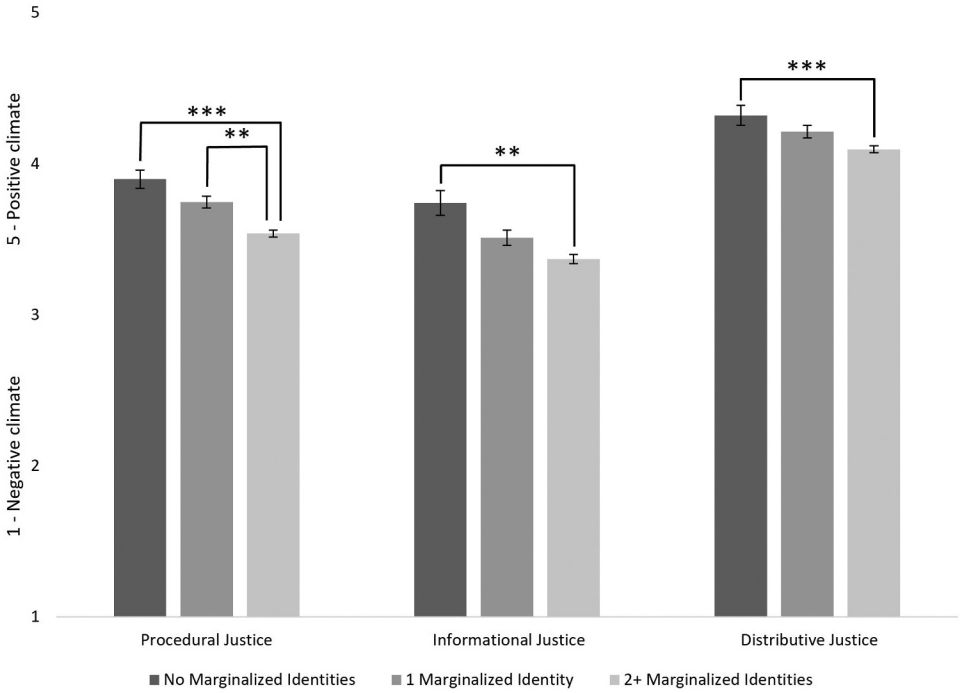

Figure 5. Mean authorship climate experiences of procedural justice (left), informational justice (middle), and distributive justice (right) by marginalization across all three dimensions of authorship climate. Error bars represent standard error of the mean. ** $p < .01$; *** $p < .001$.

power and authorship climate suggest that the identification and management of power dynamics is an important ethical issue for the scientific community (Settles et al. 2018). Examination of open-ended responses to our survey questions provided further reasons to be concerned about power dynamics and authorship climate. Several respondents indicated that they did not know how authorship order was determined and that they had no say in the process. Some raised the concern that authorship decisions were influenced by favoritism and politics within labs. As we discuss below, teams may be able to alleviate some of these issues by providing greater opportunities for communication and by instituting policies to make authorship decisions more consistent and transparent. Such changes align with the ethical importance of supporting all scientists in their careers and the major role that authorship plays in advancing scientists' careers (Smith et al. 2019a).

We also found important relationships between authorship climate and methods for assigning authorship. We found that informational justice was perceived to be greater when authorship order was determined alphabetically than when it was determined by contribution or in a hybrid manner. This makes sense, insofar as authors are likely to feel that they have been given clearer information when they know that authorship order has been

determined alphabetically than when authorship order is determined in a more complex or subjective fashion. In contrast, distributive justice was perceived to be more negative when authorship order was determined alphabetically than when it was determined by contribution or in a hybrid manner. This result likely stems from the fact that ordering authors alphabetically provides a clear procedure that everyone can understand, but it does not accurately represent each author's contribution to the paper. Interestingly, authorship norms vary by discipline, and our results seemed to be linked with those norms: authors from the fields of economics and physics reported lower distributive justice than authors from the fields of biology and psychology. This is plausibly because the fields of economics and physics are more likely to order authors alphabetically, thereby making it more difficult to assess author contributions (Sarsons 2017; Sarsons et al. 2021). Physics respondents were also most likely to report that their coauthored paper consisted of six or more people, while economics respondents were least likely to do so (47.42% in physics coauthored with 6 or more people compared to 39.08% in biology, 19.41% in psychology, and 2.92% in economics). These results suggest that the differences in distributive justice perceived by authors from physics and economics relative to those from biology and psychology are not solely associated with having a large number of authors on papers.[1]

These findings highlight the value of studying all three aspects of authorship climate (procedural, informational, and distributive justice) because they are perceived differently. In fact, policies that have positive effects on one aspect of authorship climate may detract from another aspect of authorship climate, as seen from the fact that alphabetical authorship assignments for ordering authors increase perceptions of informational justice while decreasing perceptions of distributive justice. By paying attention to these different aspects of authorship climate, it may be possible to design better systems for handling authorship decisions. For example, as discussed below, if teams order authors alphabetically, they can consider providing clear statements detailing the contributions of all the authors, whereas if teams order authors by contribution, they can consider creating team policies to clarify how author contribution is determined.

Finally, we found that individuals with more marginalized identities (e.g., women with disabilities, people of color who are gender minorities) experienced a more negative authorship climate than those with fewer marginalized identities. Those with one or more marginalized identities reported a more negative climate of procedural justice than those with no marginalized identities, and those with two or more marginalized identities reported more negative informational justice and distributive justice than those with no marginalized identities. These findings accord with previous research indicating that marginalized groups tend to perceive the climate on science teams more negatively than other team members (Settles et al. 2019), while

extending this previous work to the context of authorship climate. These findings may also help to explain some of the authorship outcomes that marginalized groups experience, such as that women are less likely than men to appear in the most prominent authorship positions on papers in some fields (Bendels et al. 2018; Fishman et al. 2017; West et al. 2013). In other words, the more negative perceptions of authorship climate reported by those with marginalized identities are likely to reflect actual differences in those individuals' opportunities and the ways they are treated on science teams. Furthermore, when these individuals perceive the climate on their teams more negatively, this can affect their overall satisfaction (Settles et al. 2019) and desire to remain in academic science. Thus, if the scientific community is serious about fostering greater opportunities for those coming from historically marginalized groups, steps need to be taken to promote a more positive authorship climate for all individuals on science teams (see Table 6).

One promising step to create more ethical and inclusive science teams would be to implement authorship policies that address power dynamics and potentially improve all three dimensions of authorship climate (see Soranno and Cheruvelil 2019 for a sample authorship policy and template). These policies can, for example, state principles and procedures for deciding who should be listed as an author on papers and how to determine authorship order (see for e.g., Oliver et al. 2018; Soranno and Cheruvelil 2019). Such policies could alleviate some of the concerns shared in the open-response portion of our survey about how authorship was determined. For example, one respondent said, "Unsure. Assume by perceived contribution but beyond first author, but [sic] never discussed." Other participants described authorship order being determined randomly, such as by "drawing names." Authorship policies can also provide regular opportunities for revisiting and revising authorship practices, which can give all team members the opportunity to discuss concerns (thereby increasing communication) and help to influence their team's authorship practices (Elliott et al. 2017). Journals and universities can also implement policies to make authorship roles more transparent, such as including authorship statements with published papers or encouraging researchers to include information about their paper contributions in their

Table 6. Potential steps for promoting positive authorship climate.

- Creating authorship policies in science teams
- Including authorship statements with published papers and CVs
- Eliminating or limiting the use of alphabetical authorship
- Creating authorship working groups as part of study protocols
- Providing authorship workshops and toolkits at scholarly society conferences
- Engaging in team-building activities
- Increasing representation from marginalized and minoritized groups in science teams
- Taking steps in research teams, universities, and scholarly societies to recognize the contributions of all team members to collaborative scholarship

CVs (McNutt et al. 2018). Our results suggest that these forms of transparency could be particularly valuable for those who tend to have less power (e.g., early-career scholars, especially those from marginalized groups) and who tend to experience authorship climate more negatively.

Importantly, our results suggest that academic fields may need to alter their policies and practices in different ways due to disparate preexisting norms. This does not mean that they need to converge on exactly the same practices; rather, different steps may be needed to promote procedural, informational, and distributive justice to account for different preexisting norms and practices. For example, we found that alphabetical approaches for assigning authorship raise ethical concerns about distributive justice. This suggests that fields like economics and physics, which rely to varying extents on alphabetical approaches for assigning authors, may want to reconsider that norm, especially given the evidence that this approach to assigning authors can potentially disadvantage those from marginalized and minoritized groups (Sarsons 2017; Sarsons et al. 2021). If they choose to keep that norm in some contexts, then it may be especially important to develop detailed authorship contribution statements to accompany publications so each author can be given appropriate credit. In fields like biology and psychology, which typically assign authors by contribution or in a hybrid fashion, our results suggest that it is particularly important to institute clear authorship procedures and opportunities for informing authors about the reasoning behind authorship decisions in order to address concerns about procedural and informational justice. For example, Marušić et al. (2014) recommend a five-step framework for making author contributions to clinical trials more transparent. Central to the framework is the creation of an authorship working group as part of the protocol for clinical trials; this working group sets criteria for what counts as "significant" contributions in the context of the trial and documents which individuals meet those criteria for authorship. As discussed previously, the development of clear authorship policies on science teams, as well as the opportunity for team members to provide ongoing feedback on them, can also increase transparency around authorship decisions (Elliott et al. 2017; Oliver et al. 2018). Professional societies and scholarly journals can help to promote these steps by setting their own policies and practices.

These structural changes will be amplified by fostering cultural changes in societies, departments, and research teams (Elliott et al. 2017). For example, societies and departments could take steps to improve the culture around authorship by sponsoring workshops about ethical authorship practices and including documents, toolkits, and case studies about authorship practices on their websites (Cheruvelil et al. 2014). Research groups can also take steps to foster a greater climate for inclusion on their teams, such as by increasing the representation of those from marginalized and minoritized groups (Settles et al. 2019), engaging in team-building activities (Cheruvelil et al. 2014), and participating in workshops designed to foster more effective communication

and collaboration (e.g., Hubbs, O'Rourke, and Orzack 2020). Given that collaborative scholarship tends to be undervalued, especially for marginalized or minoritized groups (Sarsons et al. 2017), it is also important for societies, departments, and research teams to highlight the significance of collaborative work and foster recognition for the contributions of all team members to joint projects. Efforts to do so could incorporate several of the structural and cultural changes that we have suggested, including altering tenure and promotion policies to better value collaborative activities. Finally, although work on collaborative, multi-disciplinary, and interdisciplinary teams is encouraged in the sciences, the resulting outputs with multiple coauthors are still undervalued (Sarsons 2017). Though promotion and tenure criteria vary widely across institutions, many departments do not consider research outputs from a tenure candidate if they are not the first or last author.

Future studies could explore additional ways to foster a positive authorship climate on scientific teams. As our study only looked at authorship perceptions of early-career researchers, future research could study climate perceptions of those at other career stages or in other academic positions besides those included in our study (e.g., undergraduates, associate and full professors in the tenure system, and research professors). Our study also looked at academic fields as a whole and did not draw distinctions between sub-fields, so future research could look more closely at the unique characteristics of different research sub-fields and their relationships to authorship climate experiences. It would also be helpful to investigate associations between the different dimensions of authorship climate (i.e., procedural, informational, and distributive justice) and outcomes such as scholars' overall satisfaction with their teams, their desire to persist in science, their likelihood to achieve tenure, and their productivity. If authorship climate is in fact related to one or more of these outcomes, it provides further urgency to study and improve the factors that influence authorship climate, especially for those from marginalized groups.

Conclusion

We have argued that the concept of authorship climate (consisting of procedural justice, informational justice, and distributive justice) holds significant potential as a tool for understanding people's experiences on science teams, identifying ethical concerns related to authorship, and developing responses to those concerns that improve experiences. We found that individuals who tend to have more power on teams (e.g., assistant professors and lead authors) perceived authorship climate to be more positive than those who tend to have less power (e.g., graduate students and non-lead authors). In addition, we found that authors from the fields of economics and physics —fields where alphabetical authorship is common—reported less distributive justice than authors from the fields of biology and psychology, where

alphabetical authorship is less common. Nevertheless, although alphabetical approaches for assigning authorship were associated with more negative experiences of distributive justice, they were associated with more positive experiences of informational justice. Finally, we found that individuals with more marginalized identities reported worse authorship climates than those with fewer marginalized identities. This finding accords with previous research indicating that marginalized groups tend to perceive the climate on science teams more negatively than other team members (Settles et al. 2019).

Our investigation of authorship climate indicates that power, disciplinary norms, and marginalized group membership all affect authorship experiences in important ways that can thwart equity in the sciences. Given our finding that those with more marginalized identities tend to perceive authorship climate more negatively than those with more privileged identities, it is especially important to study whether those experiences could be contributing to the "leaky pipeline" that leads to fewer women and racially marginalized scholars in leadership positions in academia. In the meantime, it is important to implement and further investigate interventions that are likely to improve authorship climate. Strategies include creating authorship policies and authorship working groups for teams to improve procedural and informational justice, providing contribution statements with papers to increase distributive justice, and taking steps to help teams communicate more effectively to enhance authorship climate overall. Given the central role that coauthoring and publishing plays in scientific careers, it is incumbent on the scientific community to take steps to ensure that all scientists can have procedurally, informationally, and distributively fair authorship experiences.

Note

1. Some sub-fields of physics (e.g., high-energy particle physics) can have papers with thousands of authors (Birnholtz 2006), which has the potential to generate unique challenges and authorship climate perceptions. As noted in the main text, the number of authors does not appear to be the only factor associated with lower distributive justice perceptions in our survey, but it would be valuable in further research to look more closely at the unique characteristics of different disciplines and their sub-fields to explore their impact on authorship climate.

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HD and KCE conceptualized the paper, and KCE led the writing process. All authors participated in framing the paper, interpreting results, and writing and editing the manuscript. HD and IS led the data collection and analysis, with assistance from TD and LN. KSC, KCE, GM, and IS obtained funding, and KSC and IS administered the project.

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Appendix

Authorship Climate Scale

Unless indicated with *, scale items were adapted from:

Colquitt, Jason A. (2001). On the dimensionality of organizational justice: A construct validation of a measure. Journal of Applied Psychology, Vol 86(3), 386–400. doi: 10.1037/0021-9010.86.3.386

Participants who had previously coauthored a manuscript were asked to "think about one recent manuscript that is typical of your experiences collaborating."

Procedural Justice subscale

Instructions:

The next questions are about the **procedures used to make authorship decisions** on coauthored manuscripts. By authorship decisions we are referring to who is included as an author and how author order is determined. Think about the same coauthored manuscript that you previously described. To what extent:

Response options:

(1) Not at all (2) A little bit (3) A moderate amount (4) Very much (5) Completely

(1) Were you able to express your views and feelings about who was an author on the manuscript?
(2) Were you able to express your views and feelings about how author position (e.g., lead or first author) was determined?
(3) Did you have the ability to influence who was included as an author?
(4) Were authorship practices applied consistently and equally to every coauthor in your collaboration?
(5) Were authorship practices free of bias?
(6) *Was everyone involved in the project given the opportunity to earn authorship on the manuscript?

Informational Justice subscale

Instructions:

The next questions are about **communication around authorship decisions** on the coauthored manuscript. By authorship decisions we are referring to who is included as an author and how author order is determined. As with the previous questions, think about the same coauthored manuscript that you described. To what extent:

Response options:

(1) Not at all (2) A little bit (3) A moderate amount (4) Very much (5) Completely

(1) Were people in your coauthorship candid in their communications about how authorship was determined?
(2) Were people in your coauthorship thorough in their explanations about how authorship was determined?
(3) *Were all coauthors included in conversations about authorship?

Distributive Justice subscale

Instructions:

The next questions are about **authorship order and position** in your coauthored manuscript. As with the previous questions, think about the same coauthored manuscript that you described. To what extent:

Response options:

(1) Not at all (2) A little bit (3) A moderate amount (4) Very much (5) Completely

(1) Did your author position reflect the effort you put into the publication?
(2) *Did your author position reflect what you contributed to the publication?
(3) Did your author position reflect what you contributed to the overall project that led to the publication?
(4) Did the authorship on the publication reflect everyone's effort appropriately?