Science Advances

AAAS

Supplementary Materials for

The gendered nature of authorship

Chaoqun Ni, Elise Smith, Haimiao Yuan, Vincent Larivière, Cassidy R. Sugimoto*

*Corresponding author. Email: sugimoto@gatech.edu

This PDF file includes:

Supplementary Materials and Methods
Tables S1 to S7
Figs. S1 to S5
Survey instrument

Supplementary Materials

Supplemental materials and methods

We used an in-house version of the Web of Science database to construct the sampling frame representing the population of researchers who have published collaborative articles between 2011 and 2015. Authors and their papers were disambiguated using characteristics such as the institution of affiliation (using the link between authors and institutional addresses found in the Web of Science), as well as researchers' email addresses. As the Web of Science typically indexes only one email address per paper (for corresponding author), our sampled authors have, at one point in their career, been corresponding authors on a manuscript. Once disambiguation was completed, we removed from our dataset non-collaborative authors—that is, authors those who have never contributed to papers that have more than one author. This led to a sampling frame of 3,487,882 possible researchers, from which a sample of 103,396 researchers was drawn. Researchers were assigned to a country as a function of the most frequent country appearing on their papers and assigned to a discipline as a function of the main discipline appearing on their papers. The survey was stratified by researchers' levels of interdisciplinarity, based on their papers' percentage of references made to other disciplines.

The survey was sent through email using the Qualtrics software on May 24th, 2016, with two reminders sent to authors who had not yet responded within the month following the original invitation. 14.1% of email invitations (N=14,526) never reached any respondents, due nonexistent addresses, full mailboxes, junk filters, etc. Responses were received from 8,364 respondents (for a response rate of 9.4% from the 88,771 that were marked as delivered); however, only 5,730 returned full surveys (for a response rate of 6.5%). 155 responses from Arts and Humanities were removed from analysis and 5,575 responses from remaining disciplines were kept. This forms the analytical sample for the present study. Survey respondents indicated their disciplines of research based on the National Science Foundation field and subfield classification, which were later re-categorized into larger disciplinary areas (see Table S1) due to two reasons: 1) The number of discipline categories is large and makes cross-disciplinary comparison difficult; and 2) the number of respondents in each discipline varies distinctively. Table S2 provides the number of researchers in the population, sample, respondents, and analytical sample. It shows that researchers from the social sciences slightly are overrepresented in the analytical sample, while researchers from medical sciences and natural sciences and engineering are underrepresented. Researchers from most Western countries are also overrepresented, mostly to the expense of Asian countries (Table S3). From a gender point of view, men and women has similar response rates (Table S4), and the algorithmically assigned gender used to assess genders' response rate is a strong predictor of respondents' declared gender (Table S5). Finally, respondents were divided fairly equally among early-, mid-, and late-career researchers (Table S6).

Table S1. Grouping of disciplines into 3 disciplinary areas

Disciplinary Areas	Disciplines
Social Sciences (SS)	Professional Fields
	Social Sciences
	Psychology
Medical Sciences (MS)	Biomedical Research
	Clinical Medicine
	Health
Natural Sciences & Engineering (NS&E)	Chemistry
	Earth & Space
	Biology
	Engineering & Technology
	Mathematics
	Physics

Table S2. Population, surveyed researchers, respondents, and analytical sample, by discipline

Discipline	Population		Surveyed		Respondents		Analytical Sample	
	N	%	N	%	N	%	N	%
AH	24,029	0.7%	2,161	2.1%	251	3.0%	0	0%
SS	334,595	9.6%	12,519	12.1%	1,471	17.6%	1,097	19.7%
MS	1,313,324	37.7%	32,395	31.4%	2,488	29.8%	1,800	32.3%
NS&E	1,815,934	52.1%	56,221	54.4%	4,139	49.6%	2,678	48.0%
All Areas	3,487,882	100.0%	103,296	100.0%	8,349	100.0%	5,575	100.0%

Table S3. Population, surveyed researchers, respondents, and analytical sample by country

Country	Population		Sample		Respondents		Analytical sample	
	N	%	N	%	N	%	N	%
United States	698522	20.0%	19,932	19.3%	1,717	20.6%	1,312	23.5%
China	439104	12.6%	9,741	9.4%	188	2.3%	82	1.5%
Germany	176427	5.1%	5,130	5.0%	249	3.0%	186	3.3%
United Kingdom	178109	5.1%	5,463	5.3%	324	3.9%	230	4.1%
Japan	139738	4.0%	3,574	3.5%	177	2.1%	107	1.9%
France	136990	3.9%	4,044	3.9%	247	3.0%	153	2.7%
Brazil	122465	3.5%	4,977	4.8%	507	6.1%	329	5.9%
Italy	113616	3.3%	2,767	2.7%	333	4.0%	243	4.4%
India	112578	3.2%	3,877	3.8%	422	5.1%	233	4.2%
Spain	108152	3.1%	3,287	3.2%	312	3.7%	193	3.5%
Canada	99978	2.9%	2,748	2.7%	364	4.4%	281	5.0%
Australia	87825	2.5%	2,601	2.5%	217	2.6%	174	3.1%
Republic of Korea	74411	2.1%	2,235	2.2%	80	1.0%	31	0.6%
Netherlands	65085	1.9%	1,745	1.7%	110	1.3%	78	1.4%
Iran	58691	1.7%	1,615	1.6%	138	1.7%	66	1.2%
Turkey	58542	1.7%	1,690	1.6%	199	2.4%	82	1.5%
Russia	54157	1.6%	3,420	3.3%	286	3.4%	136	2.4%
Taiwan	51757	1.5%	1,197	1.2%	59	0.7%	33	0.6%
Poland	45870	1.3%	1,475	1.4%	90	1.1%	57	1.0%
Sweden	42426	1.2%	1,064	1.0%	90	1.1%	68	1.2%
Switzerland	37790	1.1%	1,055	1.0%	86	1.0%	69	1.2%
Belgium	33453	1.0%	949	0.9%	63	0.8%	54	1.0%
Mexico	29251	0.8%	1,061	1.0%	145	1.7%	106	1.9%
Denmark	26535	0.8%	686	0.7%	56	0.7%	47	0.8%
Portugal	24765	0.7%	826	0.8%	119	1.4%	81	1.5%
Malaysia	21581	0.6%	659	0.6%	70	0.8%	44	0.8%
Argentina	20293	0.6%	699	0.7%	82	1.0%	52	0.9%
Czech Republic	20072	0.6%	691	0.7%	55	0.7%	29	0.5%
South Africa	17740	0.5%	758	0.7%	93	1.1%	64	1.1%
Romania	16300	0.5%	833	0.8%	99	1.2%	57	1.0%
Others (N=167)	375,659	10.8%	12,497	12.1%	1,372	16.4%	898	16.1%
All	3,487,882	100.0%	103,296	100.0%	8,349	100.0%	5,575	100.0%

Table S4. Population, surveyed researchers, respondents, and analytical sample by gender (based on the gender algorithm described in (6))

Gender	Population		Sample		Respondents		Analytical sample		
	N	%	N	%	N	%	N	%	%*
Men	1,620,843	46.5%	46,358	44.9%	3,532	42.3%	2,389	42.9%	62.5%
Women	819,202	23.5%	22,066	21.4%	1,996	23.9%	1,432	25.7%	37.5%
Unknown	1,047,837	30.0%	34,872	33.8%	2,821	33.8%	1,754	31.5%	-
All genders	3,487,882	100.0%	103,296	100.0%	8,349	100.0%	5,575	100.0%	100.0%

* Percentage based on researchers for which a gender could be assigned.

Table S5. Distribution of survey respondents by declared gender (survey) and algorithmically assigned (based on the gender algorithm described in (6))

Algorithm	Survey					
	Men		Women		ALL	
	N	%	N	%	N	%
Men	2,325	97.3%	64	2.7%	2,389	42.9%
Women	77	5.4%	1,355	94.6%	1,432	25.7%
Unknown	1,164	66.4%	590	33.6%	1,754	31.5%
ALL	3,566	64.0%	2,009	36.0%	5,575	100.0%

Table S6. Gender distribution of survey respondents by disciplinary area and career stage

Career stage	SS (N=1,097)				MS(N=1,800)				NS&E (N=2,678)				ALL (N=5,575)			
	Men		Women		Men		Women		Men		Women		Men		Women	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Early Career (N=1,642)	129	48.9%	135	51.1%	280	49.7%	283	50.3%	570	69.9%	245	30.1%	979	59.6%	663	40.4%
Mid-Career (N=1,629)	149	47.6%	164	52.4%	295	57.6%	217	42.4%	606	75.4%	198	24.6%	1050	64.5%	579	35.5%
Late Career (N=1,239)	228	69.5%	100	30.5%	244	65.8%	127	34.2%	456	84.4%	84	15.6%	928	74.9%	311	25.1%
Other (N=1,065)	79	41.1%	113	58.9%	169	47.7%	185	52.3%	361	69.6%	158	30.4%	609	57.2%	456	42.8%
ALL (5,575)	585	53.3%	512	46.7%	988	54.9%	812	45.1%	1993	74.4%	685	25.6%	3566	64.0%	2009	36.0%

Incomplete Reponses

About 2,400 surveys were started but not completed. 849 participants with incomplete responses finished at least one question. Given that demographic questions were asked at the end of the survey, incomplete responses were often missing this information (e.g., gender, rank, discipline, etc.). We compared basic statistics on several questions between the incomplete and complete group. For instance, we compare the percentages of incomplete and complete group answering "yes" to certain questions. For most of the questions examined, there were no major distinctions observed.

Initial Exploratory Analysis

Data collected from the questionnaire were categorical or ordinal in nature. Therefore, we employed several categorical data analysis techniques as the first step of exploratory analyses. For most variables that are examined in this paper, univariate analysis Pearson's chi-square test was conducted to compare the distribution of categorical variables between

different gender groups. For variables with small sample sizes (usually n≤10), Fisher's exact test was utilized to compare the difference between gender groups. The statistical significance level was set at the level of 0.05. This provided an overview of how men and women responded differently to certain variables.

Confounding Variables

Academic career status and disciplinary area of scientists are two confounding variables, as both are likely related to each gender's responses to questions. To better explore gender difference, logistic regressions was performed with the two variables (academic rank/role and disciplinary area) being controlled in the overall model. With this method, we were able to rule out the possible effects of these two variables.

Regression Analysis

The regression procedures include ordinal logistic regression, multinomial logistic regression, and multiple logistic regression. Regression analysis is usually used to explore relationships between dependent and independent variables. The most common is linear regression, in which:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_1 Z_i + \ldots + e_i$$

where with one unit change in X there is β_1 differences in Y after Z and other variables are controlled. However, this approach assumes that all dependent variables are normally distributed. Furthermore, it often assumes that dependent variable Y is continuous. Our dataset, like many social science surveys, is replete with categorical variables. We want to understand whether there is a gendered difference when selecting one category over another. Therefore, we turn to logistic regression. Specific procedures and analysis methods vary by the scale of dependent variables, as well as the number of variable categories.

For questions with answers measured in ordinal scales (e.g., Likert Scaling), ordinal logistic regression analysis was employed. For instance, we employed ordinal logistic regression to compare the difference between responses from women and men to the value of study design in research. In this question, respondents evaluated the contribution of study design on a Likert Scale from "not at all important" to "extremely important". Level of importance, therefore, constitutes the dependent variable in this analysis. Gender is the independent variable with two categories of values: women and men. Academic role and disciplinary area were the two controlled variables in the analysis. The statistical significance level was set at 0.05. By using ordinal logistic regression analysis, an odds ratio of women over men would be generated. When the odds ratio was statistically larger than 1, it represented that women were more likely than men to rate a higher importance level for the contribution of study design. An odds ratio value that is significantly smaller than 1 indicates that men are more likely than women to rate a higher importance level. Statistical significance could also be expressed from the confidence interval of the odds ratio. For a 95% confidence interval, we are 95% confident that the true population odds ratio falls between the lower and upper bound of this interval. An odds ratio confidence interval, including one, represents a statistical non-significance.

For questions with answers (the dependent variables) presented in a categorical, unordered scale, multinomial logistic regression (when the dependent variable contains more than two categories) or multiple logistic regression (when the dependent variable only contains two categories) was performed. The point statistic was still the odds ratio of

women over men. For instance, when respondents chose the author who they think should receive most recognitions from "first author", "last author" and "all authors", the author variable is an unordered dependent variable with three categories when we performed the multinomial logistic regression. Gender here again is the independent variable, with the academic role and disciplinary areas being the controlled variables. In multinomial logistic regression, one category of the dependent variable will be used as the baseline (reference category) to compare with the remaining variables. Each of the variable categories will have an odds ratio value from the regression analysis. In this analysis, the "last author" category of the dependent variable was considered as the reference category. A women to men odds ratio over 1 for "first author" category indicates that women were more likely than their men to choose "first author" over "last author" as the candidate for receiving most recognitions.

In the case when a dependent variable only has two categories (e.g., "yes" or "no" to an answer), multiple logistic regression analysis was conducted to analyze the data. An odds ratio value significantly over 1 indicates that women was more likely than men to select "Yes" for this question. Similarly, the academic role and disciplinary area variables are controlled.

Multiple testing is not a problem here, as we analyze gender differences separately on each hypothesis. Data on different disciplines were also tested separately: we were not trying to ascertain whether there were disciplinary differences, but rather there were gender differences within each discipline. This approach also solves the problem of differential response rates, given that each discipline was analyzed separately. In terms of response rates by gender, the response rates are not strongly different that global rates of gender participation in the scientific workforce.

Odds ratio

We use odds and odds ratio to quantify the potential gender difference in terms of contributing to the responses to survey questions. More specifically, we compare the odds of each gender opting an answer for each question in each disciplinary area separately. In the case when the dependent variable has two categories, the odds ratio provides a way to compare the relative odds of the occurrence of the outcome (e.g., yes vs no) given independent variables (e.g., men and women). If the odds ratio is close to one, in means that the independent variables have nearly the same probabilities of one outcome variable rather than the other. If the odds ratio is much larger, it means a higher probability of one outcome over the other. Using logistic regression, we can examine the odds ratio while controlling for other confounding variables. In our study, the controlled variables are discipline and career stage.

For Likert-scale type questions where the answer values range from 1-5 (e.g. from "not at all important" to "extremely important"), we utilize ordinal logistic regression. The odds ratio in ordinal logistic regression test whether one gender has a higher/lower probability to select the higher ordered category compared to another gender group. If the odds ratio from the ordinal logistic regression is significantly larger than 1, it means that focus group is more likely to select a higher ordered category than reference group. If the odds ratio is less than 1, it means that the focus group is less likely to select a higher ordered category than reference group.

Table S7. Descriptive statistics and model parameters (in odds ratio) for questions of interest

	Overall	Social Science	Natural Science & Engineering	Medical Science

	M	F	Adjusted Odds ratio	M	F	Adjusted Odds ratio	M	F	Adjusted Odds ratio	M	F	Adjusted Odds ratio
When you are leading a team research project, when do you discuss authorship?												
When the team is first formed, at the outset of the research project	32.91%	39.60%	1.17 *	43.52%	45.31%	1.14	24.95%	28.05%	1.17	42.74%	45.77%	1.19
Continuously throughout the research project	35.12%	36.58%	1.04	34.64%	40.23%	1.34*	32.29%	30.52%	0.96	41.13%	39.39%	0.97
During the manuscript writing process	54.41%	54.59%	1.06	48.29%	54.69%	1.28*	56.19%	52.76%	0.91	54.44%	56.07%	1.12
When the manuscript is ready to be published	19.10%	15.09%	0.733 ***	20.31%	16.80%	0.80	18.86%	14.39%	0.72**	18.85%	14.60%	0.71**
We never discuss authorship	4.02%	2.63%	0.726	3.75%	2.93%	0.82	4.99%	2.91%	0.59*	2.22%	2.21%	0.96
I have never lead a team research project	8.54%	11.81%	1.34**	7.51%	10.94%	1.32	10.48%	15.55%	1.28	5.24%	9.20%	1.52*
Other	2.79%	3.03%	1.05	3.41%	4.30%	1.36	2.30%	1.89%	0.85	3.43%	3.19%	1.03
In working with other researchers on a team project (not as the leading researcher), when, in your experience, is authorship discussed?												
When the team is first formed, at the outset of the research project	26.27%	30.17%	1.06	34.13%	36.13%	1.12	21.71%	22.97%	1.04	30.85%	32.52%	1.07
Continuously throughout the research project	26.55%	26.65%	0.98	26.96%	27.15%	0.98	26.80%	25.44%	0.91	25.81%	27.36%	1.07
During the manuscript writing process	61.75%	65.56%	1.23**	54.61%	64.65%	1.49**	63.97%	64.97%	1.06	61.49%	66.63%	1.29*
When the manuscript is ready to be published	27.05%	27.00%	0.95	27.65%	25.98%	0.92	26.70%	24.85%	0.86	27.42%	29.45%	1.09
We never discuss authorship	7.12%	7.54%	1.07	5.63%	8.79%	1.48	7.83%	7.99%	0.99	6.55%	6.38%	0.96
I have never lead a team research project	1.20%	0.89%	0.72	1.19%	1.17%	0.89	1.30%	0.87%	0.64	1.01%	0.74%	0.73
Other	2.71%	3.13%	1.07	3.41%	3.52%	0.96	2.35%	2.03%	0.89	3.02%	3.80%	1.28
In your experience, who usually decides which individuals to include as authors? (Multinomial logistic regression was conducted)												
The Principal Investigator, without consultation with the team	9.38%	12.11%	1.15	9.08%	12.60%	1.18	8.55%	11.64%	1.16	11.22%	12.19%	1.08
The Principal Investigator, after consultation with the main contributors	48.68%	50.92%	base	38.01%	39.96%	base	46.20%	51.53%	base	59.96%	57.27%	base

A few main contributors arrive at a consensus	19.46%	15.89%	0.81**	21.58%	16.14%	0.70*	20.71%	15.57%	0.68**	15.67%	16.01%	1.06
All contributors come to a common agreement	20.33%	18.73%	0.94	28.94%	28.15%	0.95	22.02%	19.51%	0.81	11.83%	12.19%	1.1
Other	2.16%	2.34%	1.09	2.40%	3.15%	1.59	2.51%	1.75%	0.62	1.31%	2.34%	1.82

How important are the following criteria in naming authors? Not at all important to extremely important: 1 to 5.
((Ordinal logistic regression was conducted)

What they contributed to the research project	mean4.47	mean4.52	1.15*	Mean 4.56	Mean 4.50	0.91	Mean4.43	Mean 4.52	1.31**	Mean 4.53	Mean 4.55	1.15
Overall time spent working on the research project	3.54	3.75	1.38***	3.63	3.81	1.39**	3.47	3.75	1.62***	3.64	3.71	1.15
Taking responsibility for the research process and results	3.93	4.14	1.58***	3.90	4.11	1.73***	3.89	4.11	1.63***	4.05	4.18	1.49***
Securing funding	2.75	2.93	1.28***	2.54	2.81	1.51***	2.73	2.98	1.42***	2.92	2.96	1.05
Leadership	3.41	3.53	1.24***	3.21	3.41	1.44**	3.36	3.47	1.28**	3.62	3.65	1.12
Technical work (e.g., data collection, statistical analysis, experiments)	3.55	3.66	1.23***	3.43	3.49	1.07	3.57	3.77	1.41***	3.57	3.67	1.15
Academic rank	1.98	2.11	1.16***	1.89	2.03	1.16	1.97	2.16	1.26**	2.05	2.11	1.03

Have you ever encountered disagreement regarding authorship naming?
(Multinomial logistic regression was conducted)

Yes	44.69%	53.09%	1.38***	37.61%	48.72%	1.53**	41.34%	49.64%	1.50***	55.61%	58.74%	1.17
No	47.21%	39.54%	base	53.50%	44.99%	base	49.92%	40.47%	base	38.02%	35.34%	base
I am not sure	8.1%	7.37%	1.11	8.89%	6.29%	0.80	8.73%	9.90%	1.38*	6.37%	5.91%	0.99

Frequency of authorship naming disagreement.
(Ordinal logistic regression was conducted)

Rarely	72.23%	63.17%		76.92%	64.26%		73.88%	63.93%		67.88%	62.05%	
Less than half of the time	19.45%	26.43%		18.10%	26.10%		17.90%	23.75%		22.32$	28.51%	
About half the time	6%	7.5%	1.35***	3.17%	8.03%	1.53**	5.80%	8.21%	1.49**	7.44%	6.71%	1.14
Most of the time	1.69%	2.81%		0.45%	1.61%		1.93%	4.11%		1.81%	2.52%	
Always	0.63%	0.09%		1.36%	0.00%		0.48%	0.00%		0.54%	0.21%	

What factors caused or contributed to disagreements among team members?

Differing disciplinary practices	8.07%	10.12%	1.23*	8.19%	11.91%	1.60*	6.94%	6.98%	1.09	10.28%	11.66%	1.19
Different ways of valuing or measuring the importance of contribution	29.65%	38.81%	1.46***	22.87%	33.59%	1.66***	27.05%	37.79%	1.63***	38.91%	42.94%	1.21
Confusion or lack of clarity	17.98%	20.40%	1.1	12.80%	20.70%	1.76**	16.12%	18.02%	1.11	24.80%	22.21%	0.89

regarding authorship definitions												
Differing values	9.69%	11.22%	1.1	8.53%	10.74%	1.32	8.73%	9.74%	1.06	12.30%	12.76%	1.04
Differing ethics	11.64%	13.20%	1.17	8.70%	13.09%	1.57*	12.08%	13.52%	1.15	12.50%	13.01%	1.02
Difference between the team's authorship practices and those of the journal	3.41%	4.37%	1.19	1.54%	3.71%	3.03**	2.50%	2.91%	1.16	6.35%	6.01%	0.98
Lack of agreement within the team	12.48%	14.39%	1.1	10.24%	13.67%	1.43	11.23%	11.63%	1.03	16.33%	17.18%	1.05
Other	3.29%	4.37%	1.24	4.78%	5.47%	1.22	2.64%	3.05%	1.18	3.73%	4.79%	1.3
Have you observed any of the following behaviors from scholars as a result of an authorship naming disagreement?												
Being hostile towards colleagues	23.56%	27.49%	1.20**	21.50%	28.71%	1.54**	21.81%	27.18%	1.34**	28.33%	26.99%	0.94
Undermining the work of colleagues during group meetings/talks	16.44%	17.17%	1.04	13.14%	15.04%	1.15	16.57%	16.86%	0.99	18.15%	18.77%	1.03
Cutting corners on research to compete with a colleague	8.35%	7.99%	0.99	5.80%	6.05%	0.99	9.18%	9.45%	1	8.17%	7.98%	0.97
Sabotaging someone's research	5.92%	6.20%	1.1	4.10%	5.66%	1.41	6.14%	7.41%	1.24	6.55%	5.52%	0.84
Producing fraudulent research to compete with or undermine the results of a colleague	3.60%	2.48%	0.7 *	1.88%	1.76%	0.85	4.04%	2.91%	0.69	3.73%	2.58%	0.68
Limiting further collaboration	38.25%	38.76%	1.02	38.40%	40.43%	1.12	37.13%	41.42%	1.19	40.42%	35.46%	0.82*
Other	3.63%	3.37%	0.87	5.12%	4.10%	0.77	3.24%	2.76%	0.85	3.53%	3.44%	0.97
No specific behavior has been observed	46.57%	45.46%	0.96	50.34%	45.12%	0.90	47.60%	44.19%	0.86	42.24%	46.75%	1.2
Have you ever engaged in any of the following behaviors as a result of an authorship naming disagreement?												
Being hostile towards colleagues	4.47%	4.71%	1.06	4.10%	5.08%	1.16	4.69%	4.51%	0.98	4.23%	4.66%	1.07
Undermining the work of colleagues during group meetings/talks	3.38%	2.78%	0.9	3.07%	2.73%	0.95	4.09%	3.20%	0.78	2.12%	2.45%	1.13
Cutting corners on research to compete with a colleague	1.56%	1.34%	0.86	0.85%	0.98%	1.12	1.75%	1.60%	0.87	1.61%	1.35%	0.79

Sabotaging someone's research	0.87%	0.55%	0.61	0.17%	0.59%	2.16	0.90%	0.58%	0.64	1.21%	0.49%	0.39
Producing fraudulent research to compete with or undermine the results of a colleague	0.73%	0.45%	0.67	0.68%	0.59%	0.79	0.90%	0.44%	0.53	0.40%	0.37%	0.87
Limiting further collaboration	26.13%	27.20%	1.08	26.62%	28.71%	1.16	24.80%	27.33%	1.2	28.53%	26.13%	0.94
Other	2.57%	3.57%	1.35	3.07%	3.91%	1.29	2.40%	2.91%	1.24	2.62%	3.93%	1.55
I have not engaged in any specific behavior	67.23%	65.71%	0.91	68.26%	64.84%	0.84	68.01%	65.55%	0.86	65.02%	66.38%	1.03
What authorship ordering conventions have been used in your collaborative research publications? (Select all that apply.)												
Alphabetical order	21.30%	20.94%	1.05	38.23%	39.45%	1.1	22.85%	19.19%	0.86	8.17%	10.80%	1.43*
Partial alphabetical order	11.00%	11.22%	1.11	12.46%	13.67%	1.14	12.18%	12.06%	1.03	7.76%	8.96%	1.25
Decreasing order of contribution	62.73%	65.66%	1.15*	65.36%	68.75%	1.18	63.37%	66.13%	1.11	59.88%	63.31%	1.19
Team leader or principal investigator last	44.67%	48.64%	1.17*	24.91%	29.30%	1.31	41.37%	45.78%	1.23*	63.00%	63.19%	1.04
Team leader or principal investigator first	32.33%	40.00%	1.22**	37.54%	46.48%	1.33*	28.94%	33.14%	1.15	36.09%	41.72%	1.23*
Team leaders or principal investigators of two groups become first/last authors, depending on who did the majority of the research	19.46%	27.79%	1.50***	11.43%	15.82%	1.52*	15.92%	25.73%	1.81***	31.35%	37.06%	1.29**
Other	6.90%	8.29%	1.32*	8.19%	7.81%	1.03	6.99%	7.99%	1.25	5.95%	8.83%	1.66**
Which author typically receives the most recognition in your collaborative publications? (Multinomial logistic regression was conducted)												
first author	68.40%	73.87%	base	67.01%	80.67%	base	66.99%	68.41%	base	72.08%	74.23%	base
last author	6.63%	8.08%	1.18	1.20%	0.39%	0.34	4.78%	7.13%	1.59*	13.60%	13.69%	1.08
all author	13.55%	8.18%	0.67 ***	17.44%	10.45%	0.53**	15.95%	10.77%	0.73*	6.40%	4.56%	0.76
I don't know	6.35%	5.24%	0.83	10.43%	5.13%	0.42***	6.64%	8.15%	1.22	3.35%	2.84%	0.8
other	5.06%	4.64%	0.99	3.93%	3.35%	0.79	5.64%	5.53%	1.04	4.57%	4.69%	1.1
Which author should receive the most recognition in your collaborative publications? (Multinomial logistic regression was conducted)												
first author	55.04%	55.01%	base	46.99%	49.02%	base	55.08%	51.09%	base	59.70%	62.07%	base
last author	4.31%	5.18%	1.22	0.86%	1.38%	1.66	2.62%	3.93%	1.86*	9.75%	8.62	0.98
all author	30.39%	28.00%	0.99	42.00%	38.39%	0.89	31.64%	31.88%	1.16	21.02%	18.23%	0.86
I don't know	3.29%	3.29%	1.08	3.10%	2.95%	0.96	3.87%	3.64%	1.02	2.23%	3.20%	1.34
other	6.98%	8.52%	1.33*	7.06%	8.27%	1.23	6.79%	9.46%	1.60**	7.31%	7.88%	1.14
Have you ever encountered disagreement regarding author order? (Multinomial logistic regression was conducted)												
Yes	36.00%	42.85%	1.25***	34.13%	42.16%	1.39*	30.86%	37.52%	1.43**	47.47%	47.78%	1.03

No	55.48%	49.03%	base	58.19%	51.96%	base	59.86%	52.41%	base	45.04%	44.33%	base
Not sure	8.52%	8.12%	1.13	7.68%	5.88%	0.89	9.28%	10.07%	1.27	7.49%	7.88%	1.09

How often do you have disagreements regarding authorship ordering in your research collaborations? (Ordinal logistic regression was conducted)

Rarely	72.72%	64.19%		75.00%	68.37%		73.82%	67.18%		70.30%	59.84%	
Less than half of the time	19.80%	26.51%		19.00%	23.26%		17.89%	25.10%		22.65%	29.27%	
About half the time	5.61%	6.86%	1.35**	4.00%	7.44%	1.08	6.02%	5.41%	1.24	5.77%	7.51%	1.54**
Most of the time	1.56%	2.09%		1.00%	0.93%		2.11%	2.32%		1.07%	2.59%	
Always	0.31%	0.35%		1.00%	0.00%		0.16%	0.00%		0.21%	0.78%	

What factors have caused or contributed to disagreement in author order among team members?

Differing disciplinary practices	7.54%	9.63%	1.30*	7.68%	10.74%	1.60*	6.69%	8.14%	1.29	9.17%	10.18%	1.19
Differing ways of valuing or measuring the importance of contribution	25.35%	32.85%	1.32***	24.06%	30.66%	1.38*	21.16%	29.07%	1.53***	34.58%	37.42%	1.12
Confusion and lack of clarify (e.g., process, criteria)	11.03%	13.45%	1.12	9.04%	15.23%	1.74**	9.08%	10.03%	1.12	16.13%	15.21%	0.92
Differing values	8.43%	9.73%	1.11	8.70%	8.40%	1.03	7.24%	7.56%	1.08	10.69%	12.39%	1.18
Differing ethics	7.68%	9.68%	1.24*	7.68%	10.16%	1.34	7.39%	8.87%	1.23	8.27%	10.06%	1.2
Differences between the team's authorship practices and those of the journal	2.85%	3.37%	1.08	1.71%	3.91%	2.80*	2.54%	1.74%	0.65	4.13%	4.42%	1.05
Lack of discussion and agreement within the team	12.23%	15.53%	1.17	11.26%	15.63%	1.46*	9.43%	11.63%	1.26	18.45%	18.77%	1.01
Other	1.90%	2.17%	1.14	3.07%	1.76%	0.5	1.65%	1.60%	1.03	1.71%	2.94%	2.06*

Have you observed any of the following behaviors from scholars as a result of an author order disagreement? (Select all that apply.

Being hostile towards colleagues	17.14%	20.35%	1.18*	18.09%	21.29%	1.20	15.57%	18.90%	1.26*	19.76%	20.98%	1.1
Undermining the work of colleagues during group meetings/talks	10.55%	11.22%	1.02	9.56%	10.55%	1.07	10.38%	8.87%	0.83	11.49%	13.62%	1.2
Cutting corners on research to compete with a colleague	4.86%	4.62%	0.94	4.10%	3.71%	0.80	5.34%	4.07%	0.74	4.33%	5.64%	1.3
Sabotaging someone's research	3.57%	2.93%	0.86	2.73%	3.13%	1.14	4.04%	3.78%	0.93	3.13%	2.09%	0.64
Producing fraudulent research to compete with or undermine the results of a colleague	2.23%	0.99%	0.44**	2.05%	0.98%	0.40	2.15%	1.16%	0.57	2.52%	0.86%	0.35*

Limiting further collaboration	27.3%	28.19%	1.03	28.50%	29.69%	1.06	25.60%	26.89%	1.1	30.04%	28.34%	0.95
Other	1.76%	1.74%	0.91	2.73%	2.34%	0.77	1.50%	1.16%	0.84	1.71%	1.84%	1.12

Have you engaged in any of the following behaviors as a result of an author order disagreement? (Select all that apply.)												
Being hostile towards colleagues	3.55%	3.42%	0.95	3.58%	4.10%	1.09	3.54%	3.05%	0.91	3.53%	3.31%	0.88
Undermining the work of colleagues during group meetings/talks	2.74%	1.79%	0.68	2.05%	1.76%	0.8	3.19%	1.60%	0.51*	2.22%	1.96%	0.84
Cutting corners on research to compete with a colleague	1.45%	1.04%	0.75	0.68%	1.17%	2.03	1.85%	0.87%	0.45	1.11%	1.10%	0.98
Sabotaging someone's research	0.75%	0.10%	0.14**	0.17%	0.00%	---	0.95%	0.29%	0.28	0.71%	0.00%	---
Producing fraudulent research to compete with or undermine the results of a colleague	0.56%	0.30%	0.54	0.68%	0.20%	0.27	0.55%	0.44%	0.82	0.50%	0.25%	0.46
Limiting further collaboration	17.78%	20.40%	1.18*	19.80%	22.27%	1.17	16.12%	19.33%	1.31*	19.96%	20.12%	1.06
Other	1.51%	1.19%	0.64	1.88%	0.78%	0.35	1.00%	0.73%	0.75	2.32%	1.84%	0.74

To what degree are individuals/institutions responsible for the overall research project in collaborative publications? "Not at all" to "A great deal": 1 to 5. (Ordinal logistic regression was conducted)												
First author	Mean 4.41	Mean 4.60	1.49***	Mean 4.39	Mean 4.58	1.76***	Mean 4.35	Mean 4.51	1.39***	Mean 4.54	Mean 4.68	1.53***
Last author	3.52	3.64	1.12 *	3.16	3.20	1.11	3.35	3.50	1.29**	4.03	4.01	0.99
All authors (unequally)	3.26	3.33	1.15 *	3.32	3.39	1.10	3.26	3.36	1.22*	3.21	3.28	1.13
All authors (equally)	3.07	3.03	0.94	3.32	3.24	0.89	3.06	3.02	0.96	2.94	2.91	0.94
Research institution of authors	2.34	2.33	0.95	2.11	2.21	1.11	2.37	2.39	0.98	2.42	2.34	0.84*
individuals named in the acknowledgment	2.00	2.03	1.04	1.84	1.95	1.14	2.03	2.10	1.11	2.02	2.01	0.91
institutions named in the acknowledgment	2.00	2.04	1.10	1.81	1.95	1.19	2.05	2.16	1.18*	1.99	1.99	0.96
Everyone who contributed to the research	2.83	2.91	1.19**	2.77	2.82	1.08	2.85	2.97	1.24*	2.81	2.92	1.22*

If there were error(s) found in your collaborative research, who would be most accountable to the public/academic communities? "Not at all" to "A great deal": 1 to 5. (Ordinal logistic regression was conducted)												
First author	Mean 4.34	Mean 4.52	1.43 ***	Mean 4.33	Mean 4.56	1.90***	Mean 4.26	Mean 4.38	1.25*	Mean 4.49	Mean 4.62	1.47***
Last author	3.50	3.63	1.12*	3.12	3.22	1.16	3.30	3.45	1.26**	4.07	4.13	0.96
All authors (unequally)	3.21	3.21	1.02	3.51	3.49	0.98	3.22	3.22	1.03	3.00	3.02	1.03

All authors (equally)	3.81	3.92	1.18 **	3.89	4.05	1.30*	3.74	3.83	1.17	3.90	3.93	1.12
Research institution of authors	2.10	2.16	1.00	1.92	2.11	1.31*	2.04	2.04	0.93	2.29	2.27	0.94
individuals named in the acknowledgment	1.40	1.37	0.87 *	1.34	1.32	0.92	1.40	1.35	0.86	1.44	1.41	0.87
institutions named in the acknowledgment	1.40	1.38	0.93	1.33	1.37	1.17	1.40	1.34	0.86	1.45	1.43	0.9
Everyone who contributed to the research	2.47	2.58	1.21 ***	2.46	2.58	1.21	2.50	2.60	1.18*	2.43	2.56	1.25*
Do you use any guidelines to help in the distribution of authorship? (Multinomial logistic regression was conducted)												
Yes	29.06%	32.39%	1.19**	26.15%	30.78%	1.42*	27.37%	25.00%	0.95	34.17%	39.66%	1.36**
No	59.93%	55.12%	base	63.42%	57.25%	base	60.54%	59.88%	base	56.65%	49.75%	base
I am not sure	11.01%	12.49%	1.23*	10.43%	11.96%	1.19	12.09%	15.12%	1.22	9.17%	10.59%	1.29
Please specify the guidelines that you have used. (Select all that apply.)												
Guidelines developed within the team/lab	16.44%	17.97%	1.20*	15.19%	20.70%	1.66**	17.81%	15.70%	0.89	14.42%	18.16%	1.41**
Departmental guidelines and Institutional guidelines	4.05%	4.62%	1.16	2.90%	4.69%	1.46	4.34%	4.07%	0.94	4.13%	5.03%	1.31
Journal guidelines	7.68%	8.83%	1.37 ***	5.80%	7.62%	1.52*	7.88%	6.83%	1.13	8.37%	11.29%	1.52***
Professional Association Guidelines	12.14%	16.87%	1.19	8.87%	12.30%	1.66*	10.63%	12.21%	1.1	17.14%	23.68%	1.09
Others	0.84%	0.50%	0.93	0.51%	0.39%	0.78	1.10%	0.58%	0.62	0.50%	0.49%	1.72
How useful were the guidelines for the following tasks: (Answered by all participants). "Not at all useful" to "Extremely useful": 1 to 5. (Ordinal logistic regression was conducted)												
Naming authors	Mean 3.79	Mean 3.74	0.91	Mean 3.88	Mean 3.58	0.63*	Mean 3.76	Mean 3.72	0.96	Mean 3.79	Mean 3.83	1.09
Ordering authors	3.58	3.47	0.88	3.84	3.66	0.67	3.61	3.57	0.92	3.40	3.33	0.92
Distributing responsibility	3.21	3.07	0.83*	3.33	3.04	0.79	3.22	3.15	0.89	3.14	3.04	0.85
Managing authorship disputes or disagreements	3.14	3.07	0.92	3.36	2.93	0.58*	3.12	3.10	0.99	3.09	3.12	1.08
To what extent have the following factors influenced authorship naming decisions in your collaborative publication(s). "Not at all" to "A great deal": 1 to 5. (Ordinal logistic regression was conducted)												
Academic rank	Mean 2.34	Mean 2.54	1.14*	Mean 2.17	Mean 2.43	1.24	Mean 2.29	Mean 2.53	1.28**	Mean 2.55	Mean 2.62	0.96
Financial contribution	2.29	2.31	1.02	1.97	2.11	1.19	2.32	2.46	1.18*	2.42	2.31	0.79**
Prestige of researcher	2.47	2.58	1.07	2.25	2.54	1.33*	2.45	2.61	1.19*	2.62	2.57	0.82*
Disciplinary culture	2.44	2.60	1.20 **	2.49	2.74	1.40**	2.41	2.56	1.28**	2.48	2.54	1
Gender	1.16	1.19	1.17	1.16	1.23	1.54*	1.17	1.19	1.04	1.14	1.17	1.15
Nationality	1.19	1.17	0.90	1.18	1.20	1.07	1.19	1.17	0.89	1.20	1.16	1.83
Technical work	3.31	3.15	0.89*	2.75	2.73	0.95	3.52	3.44	0.86	3.22	3.16	0.88
To what extent have the following factors influenced authorship ordering decisions in your collaborative publication(s)? "Not at all" to "A great deal": 1 to 5. (Ordinal logistic regression was conducted)												

|												
Academic rank	Mean 2.33	Mean 2.49	1.08	Mean 2.15	Mean 2.44	1.32*	Mean 2.28	Mean 2.45	1.18*	Mean 2.55	Mean 2.55	0.86
Financial contribution	2.09	2.14	1.04	1.80	1.99	1.24	2.10	2.24	1.19*	2.25	2.14	0.80*
Prestige of researcher	2.30	2.45	1.12 *	2.13	2.44	1.38**	2.26	2.48	1.30**	2.47	2.43	0.84*
Disciplinary culture	2.26	2.43	1.22 ***	2.33	2.63	1.52***	2.23	2.35	1.21*	2.27	2.38	1.07
Gender	1.15	1.17	1.09	1.14	1.22	1.57*	1.16	1.16	0.98	1.14	1.15	1
Nationality	1.17	1.15	0.87	1.15	1.18	1.18	1.18	1.14	0.83	1.18	1.15	0.77
Technical work	3.14	3.07	0.99	2.63	2.66	1.02	3.31	3.33	0.99	3.09	3.10	0.98
Please select the extent to which you agree with the following statements. "Disagree" to "Strongly agree": 1 to 6. (Ordinal logistic regression was conducted)												
I distribute authorship in a fair manner	5.21	5.29	1.14 *	5.30	5.35	1.17	5.19	5.22	1.06	5.19	5.32	1.25*
Colleagues distribute authorship in a manner that is unfair	2.41	2.55	1.12 *	2.38	2.59	1.26*	2.33	2.49	1.20*	2.57	2.58	0.96
I receive less credit than I deserve with regards to authorship in collaborative publications	2.21	2.31	1.11	2.08	2.36	1.32*	2.20	2.27	1.09	2.30	2.32	1.01
I receive more credit than I deserve with regards to authorship in collaborative publications	2.04	1.86	0.75 ***	1.91	1.83	0.83	2.06	1.88	0.76**	2.07	1.86	0.70***
I have concerns about the lack of guidance in authorship distribution	2.97	3.25	1.23 ***	2.73	3.17	1.47**	2.93	3.20	1.25**	3.20	3.34	1.09
I can openly and comfortably discuss authorship on research teams	4.61	4.41	0.86 **	4.74	4.47	0.77*	4.64	4.35	0.77**	4.47	4.41	1.05
Please assess the value of these contributions in your field of research. (Ordinal logistic regression was conducted)												
Study design	Mean 4.00	Mean 4.16	1.25 ***	4.02	4.11	1.2	3.86	3.98	1.31**	4.28	4.34	1.22*
Literature review	3.59	3.72	1.31***	3.66	3.76	1.25	3.54	3.74	1.53***	3.64	3.69	1.14
Data collection	3.90	4.00	1.20 **	3.83	3.92	1.2	3.85	4.06	1.49***	4.06	4.01	0.93
Data analysis	4.21	4.35	1.34***	4.19	4.32	1.36**	4.18	4.39	1.56***	4.30	4.34	1.12
Writing of the manuscript	4.32	4.49	1.48 ***	4.43	4.55	1.49**	4.26	4.40	1.40***	4.38	4.53	1.60***
Management and coordination	3.40	3.56	1.34 ***	3.32	3.39	1.16	3.33	3.57	1.60***	3.60	3.66	1.19*
Technical work (e.g., experiments)	3.84	3.71	0.92	3.40	3.36	0.94	3.98	3.98	1.02	3.84	3.68	0.80*
Other	3.22	3.35	1.18	3.28	3.54	1.38	3.24	3.34	1.11	3.14	3.27	1.21

Note: * indicates p <0.05; ** indicates p<0.01; *** indicates p<0.001; "M" indicates male; "F" indicates female. Adjusted odds ratio is the odds ratio produced by the regression model which has taken into account confounding variables.

Supplementary Figures
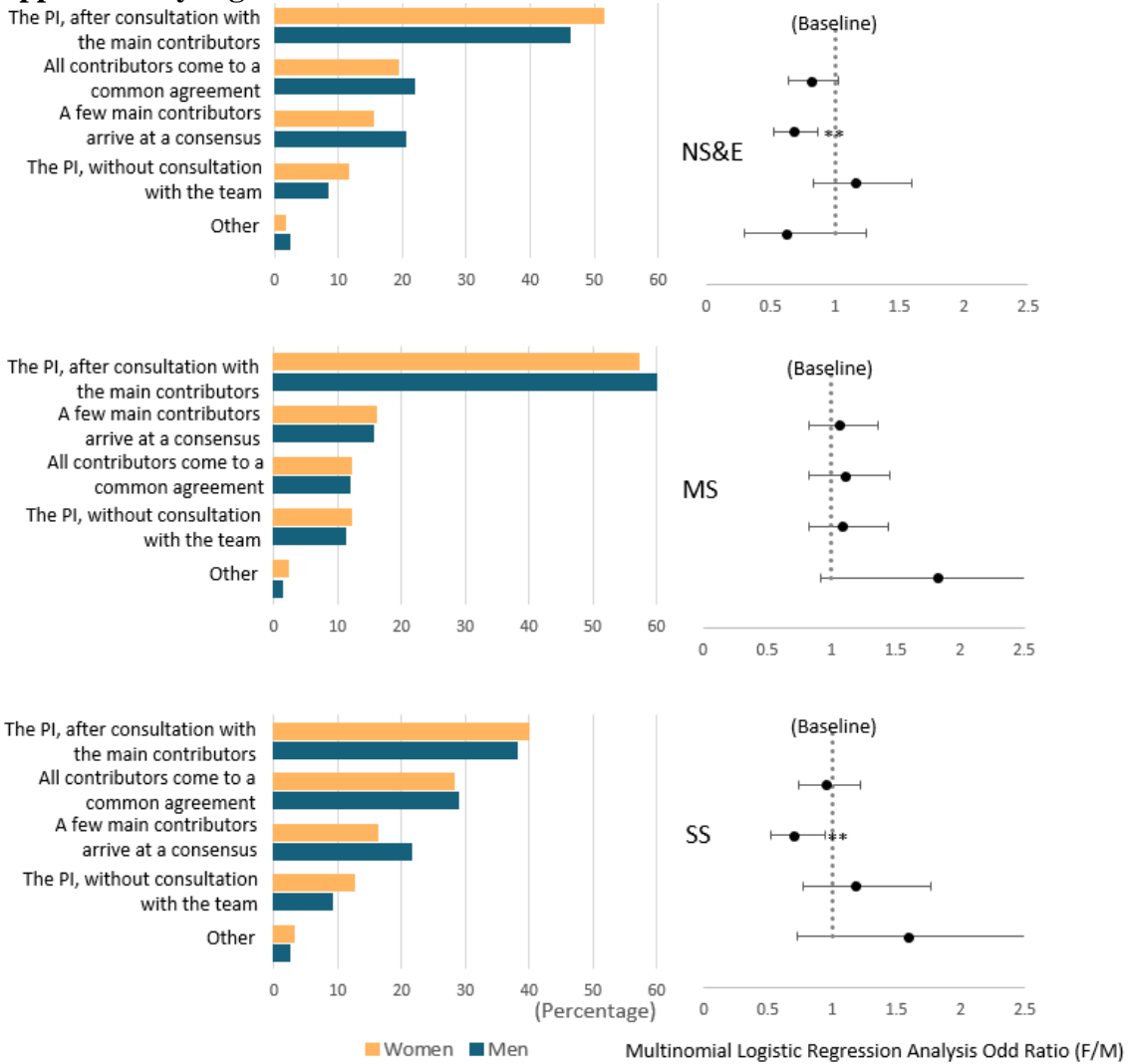
Fig. S1: Who usually decides which individuals to include as authors? Total number of valid observations: NS&E (*N*=2,676), MS (*N*=1,800), SS (*N*=1,092). Multinomial logistic regression was conducted separately for each discipline with rank controlled in the model. All statements were compared with "The PI, after consultation with the main contributors" (baseline). * indicates *p*<0.05; ** indicates *p*<0.01.
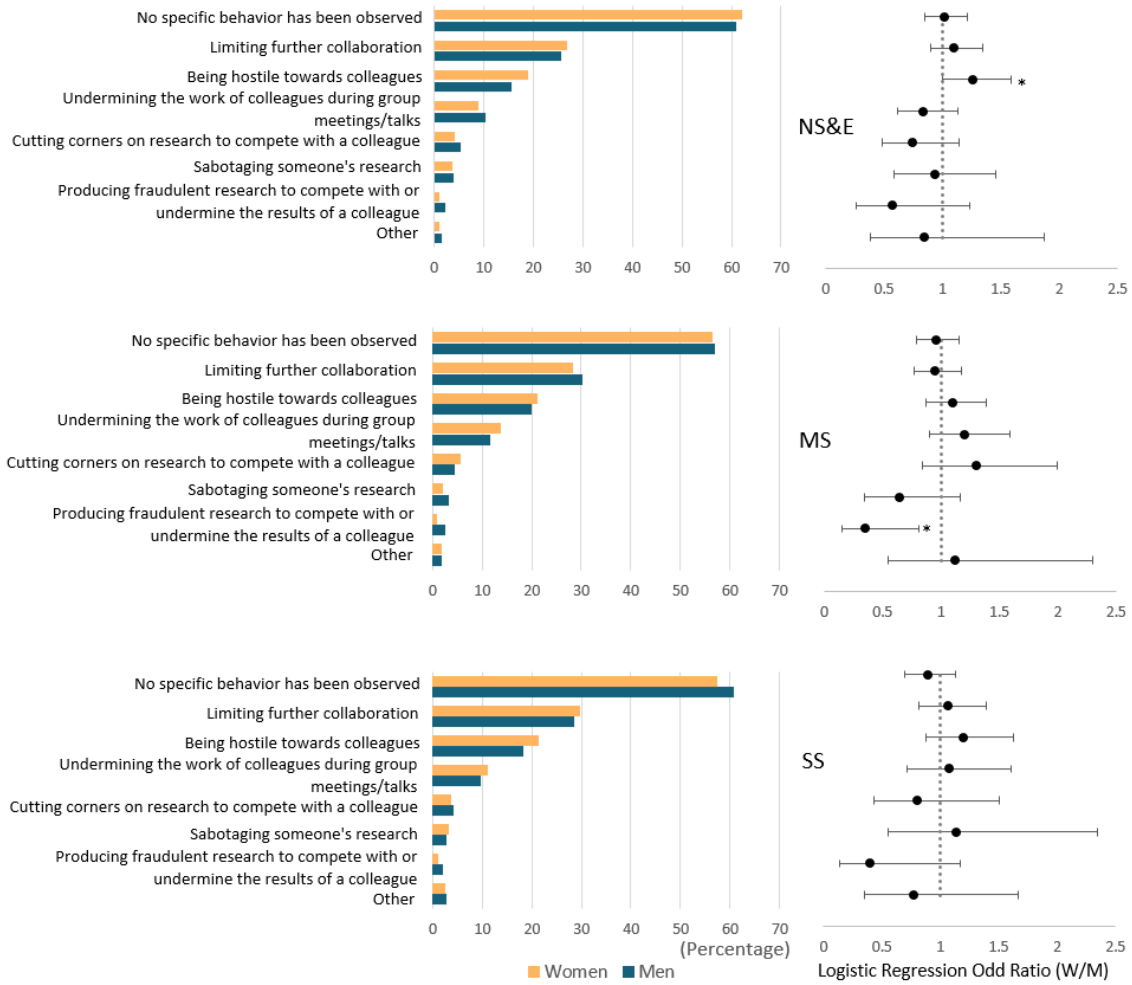
Fig. S2: Have you observed any of the following behaviors from scholars because of an authorship ordering disagreement? Total number of valid observations: NS&E (*N*=2,678), MS (*N*=1,800), SS (*N*=1,097). * indicates *p*<0.05; ** indicates *p*<0.01.
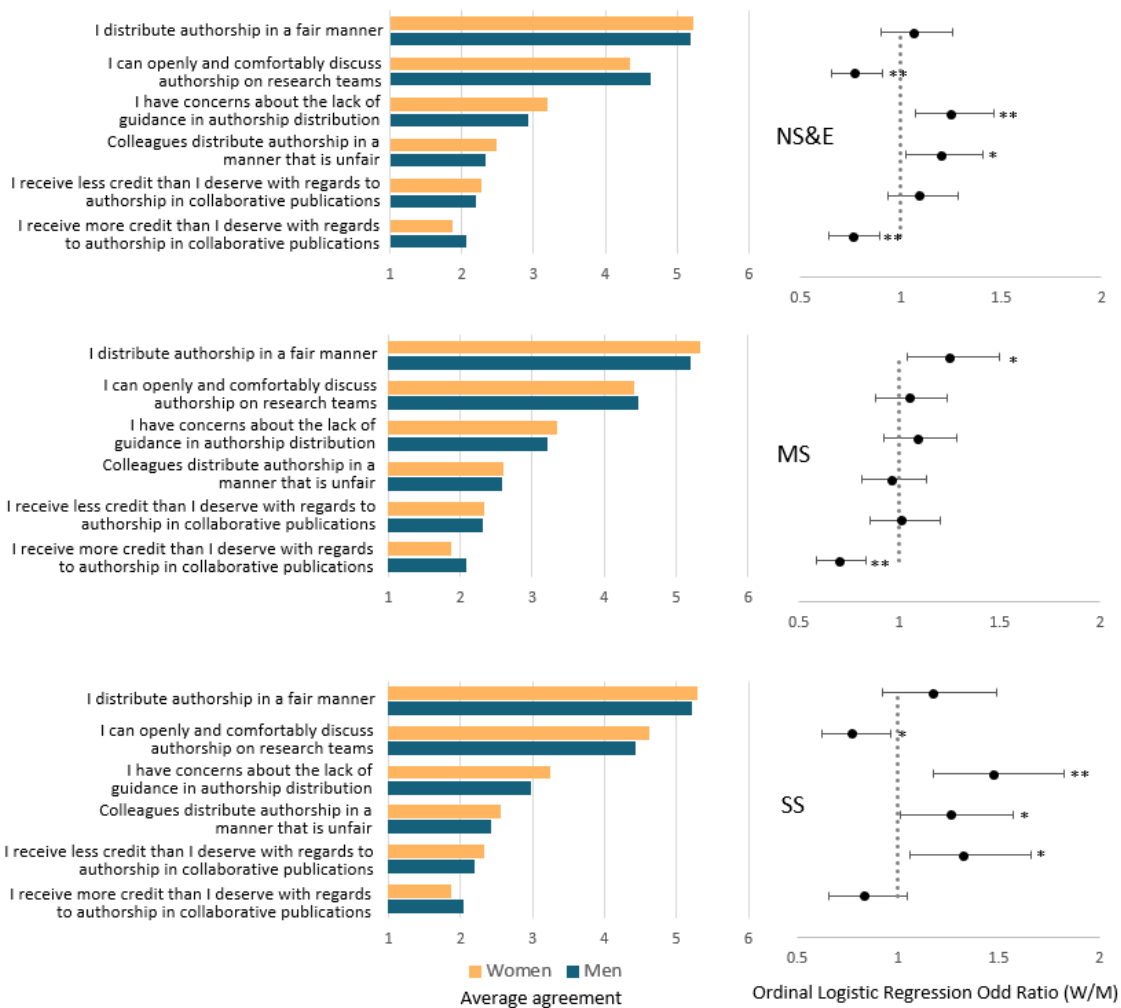
Fig. S3. Please select the extent to which you agree with the following statements. Scaled from 1-6, "disagree" to "strongly agree". Total number of valid observations: NS&E (*N*=2,643), MS (*N*=1,786), SS (N=1,077). * indicates *p*<0.05; ** indicates *p*<0.01.
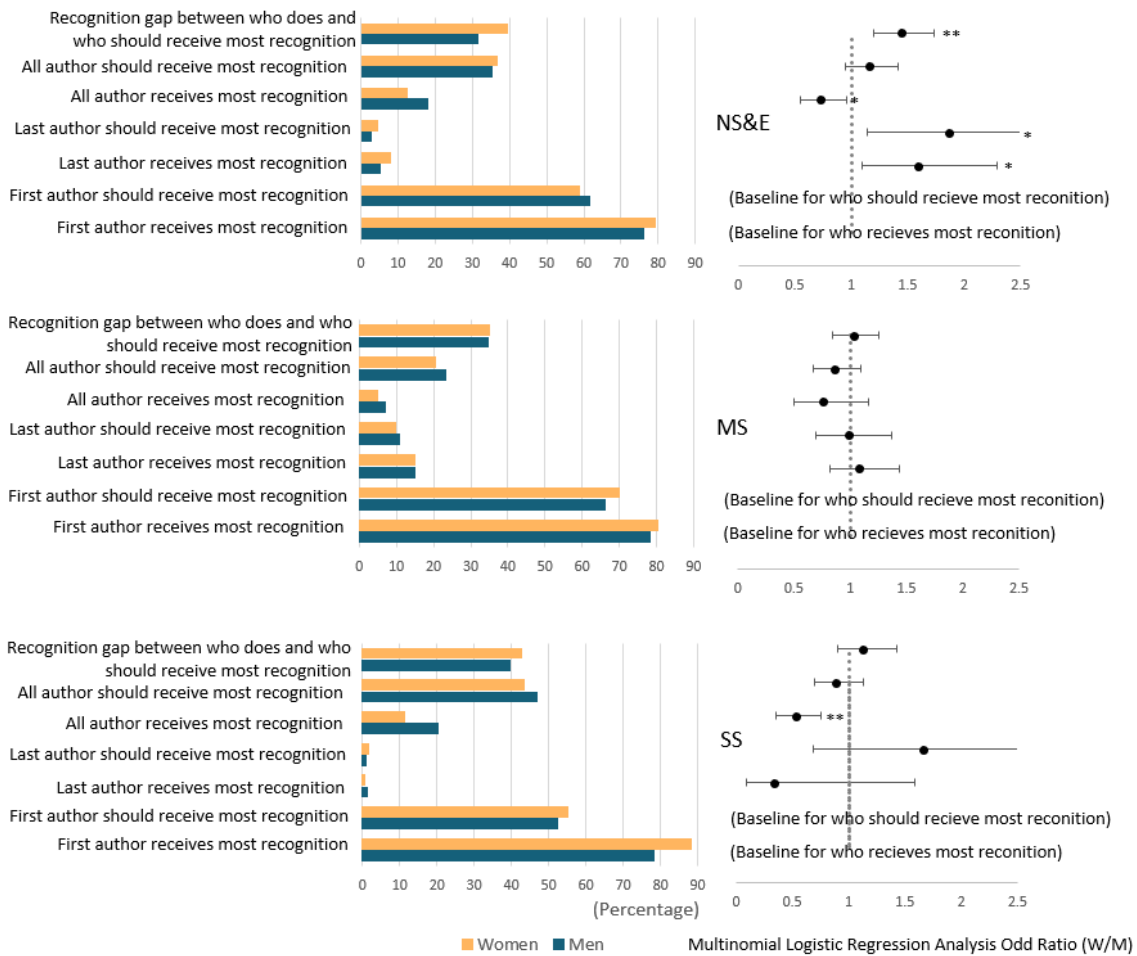
Fig. S4. Which author typically receives the most recognition in your collaborative publications? NS&E (*N*=2,336), MS (*N*=1,657), SS (*N*=965) for "should"; NS&E (*N* =2,373), MS (*N*=1,613), SS (*N*=973) for "is". Multinomial logistic regression was conducted separately for each discipline with rank controlled in the model. "All authors receive most recognition", "Last author receives mot recognition" were compared with "First author receives most recognition"; "All author should receive most recognition", "Last author should receive most recognition" were compared with "First author should receive most recognition". Binary logistic regression was conducted to explore the recognition gap between who does and who should receive most recognition (have gap vs. no gap). * indicates *p*<0.05; ** indicates *p*<0.01.
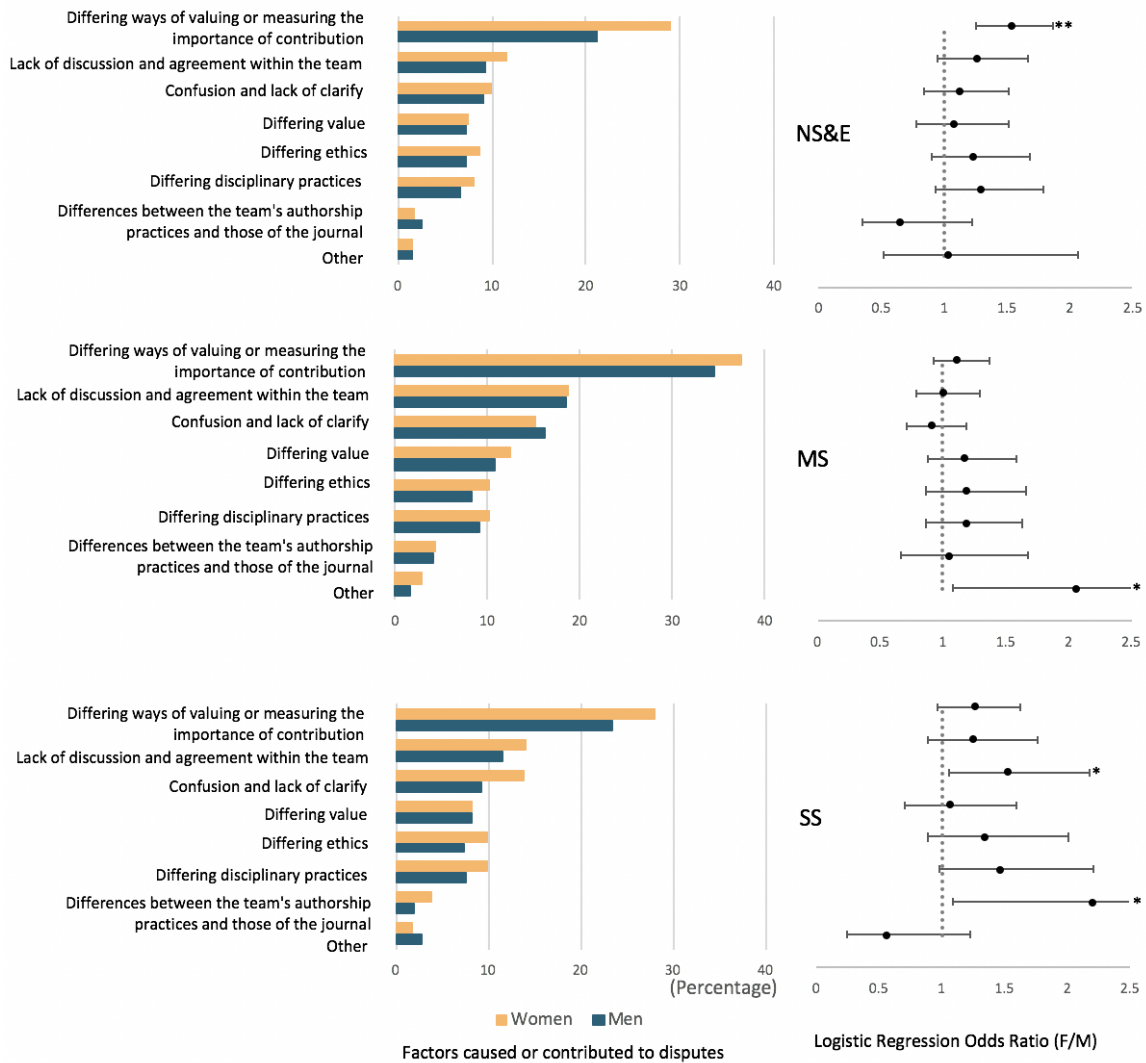
Fig. S5. What factors have caused or contributed to disagreement in author order among team members? Total number of valid observations: NS&E (*N*=2,678), MS (*N*=1,800), SS (*N*=1,097). * indicates *p*<0.05; ** indicates *p*<0.01.

Survey instrument

Note: These questions are part of a larger study on authorship and acknowledgement ethics. Only specific questions that were used during the analysis of the manuscript have been included.

Definition of authorship naming: the inclusion of different contributors as authors in a research publication.

Have you ever encountered disagreement regarding authorship **naming**?

- Yes (1)

- No (2)

- I am not sure (3)

If No Is Selected, Then Skip Next Section, If I am not sure Is Selected, Then Skip To Next Section

How often do you have disagreements regarding authorship **naming** in your research collaborations?

- Rarely (1)

- Less than half of the time (2)

- About half the time (3)

- Most of the time (4)

- Always (5)

What factors caused or contributed to disagreements among team members? (Select all that apply.)

- Differing disciplinary practices (1)

- Different ways of valuing or measuring the importance of contribution (2)

- Confusion or lack of clarity regarding authorship definitions (3)

- Differing values (4)

- Differing ethics (5)

- Difference between the team's authorship practices and those of the journal (6)

- Lack of agreement within the team (7)

- Other (please specify) (8) _____

Have you observed any of the following behaviors from scholars as a result of an authorship naming disagreement? (Select all that apply)

- Being hostile towards colleagues (1)

- Undermining the work of colleagues during group meetings/talks (2)

- Cutting corners on research to compete with a colleague (3)

- Sabotaging someone's research (4)

- Producing fraudulent research to compete with or undermine the results of a colleague (5)

- Limiting further collaboration (6)

- Other (please specify) (7) _____

- No specific behavior has been observed (8)

Have you ever engaged in any of the following behaviors as a result of an authorship naming disagreement? (Select all that apply.)

- Being hostile towards colleagues (1)

- Undermining the work of colleagues during group meetings/talks (2)

- Cutting corners on research to compete with a colleagues (3)

- Sabotaging someone's research (4)

- Producing fraudulent research to compete with or undermine the results of a colleague (5)

- Limiting further collaboration (6)

- Other (please specify) (7) _____

- I have not engaged in any specific behavior (8)

Definition of **authorship ordering**: The order in which authors are named on a research publication.

Have you ever encountered disagreement regarding author order?

- Yes (1)

- No (2)

- I am not sure (3)

If No Is Selected, Then Skip Next Section, If I am not sure Is Selected, Then Skip To Next Section

How often do you have disagreements regarding authorship ordering in your research collaborations?

- Rarely (1)

- Less than half of the time (2)

- About half the time (3)

- Most of the time (4)

- Always (5)

What factors have caused or contributed to disagreement in author order among team members? (Select all that apply.)

- Differing disciplinary practices (1)

- Differing ways of valuing or measuring the importance of contribution (2)

- Confusion and lack of clarify (e.g., process, criteria) (3)

- Differing values (4)

- Differing ethics (5)

- Differences between the team's authorship practices and those of the journal (6)

- Lack of discussion and agreement within the team (7)

- Other (please specify) (8) _____

Have you observed any of the following behaviors from scholars as a result of an author order disagreement? (Select all that apply.)

- Being hostile towards colleagues (1)

- Undermining the work of colleagues during group meetings/talks (2)

- Cutting corners on research to compete with a colleague (3)

- Sabotaging someone's research (4)

- Producing fraudulent research to compete with or undermine the results of a colleague (5)

- Limiting further collaboration (6)

- Other (please specify) (7) _____

- No specific behavior has been observed (8)

Have you engaged in any of the following behaviors from scholars as a result of an author order disagreement? (Select all that apply.)

- Being hostile towards colleagues (1)

- Undermining the work of colleagues during group meetings/talks (2)

- Cutting corners on research to compete with a colleague (3)

- Sabotaging someone's research (4)

- Producing fraudulent research to compete with or undermine the results of a colleague (5)

- Limiting further collaboration (6)

- Other (please specify) (7) _____

- I have not engaged in any specific behavior (8)

What is your present role/rank? (Select all that apply.)

- Bachelor's student (1)

- Master's student (2)

- Doctoral student or candidate (3)
- Postdoctoral fellow (5)
- Lecturer (teaching graduate or undergraduate courses)
- Technician or technician assistant (e.g., statistician, laboratory assistant) (7)
- Research assistant (8)
- Research associate (at public or private institution) (6)
- Senior researcher (at public or private institution)
- Assistant professor (9)
- Associate professor (10)
- Full professor (11)
- Emeritus professor (12)
- Other (please specify) (13) _____

What is your gender?

- Male (1)
- Female (2)
- Other (3)
- I prefer not to answer (4)

What is your area(s) of study? (Select all that apply.)

- Social Sciences (1)
- Humanities (2)
- Medical Sciences (3)
- Natural Sciences and Engineering (4)
- Other (please specify) (5) _____