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ARE ALL RESEARCHERS MALE? GENDER MISATTRIBUTIONS IN CITATIONS

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Are all researchers male? Gender misattributions in citations

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Abstract

In this project I screen academic literature for cases of misattribution of cited author's gender. In English-language scientific publications such mistakes are found to be rare, partly because there is typically no need to attribute gender in the first place. By contrast, in master theses and doctoral dissertations (in social sciences) written in the Polish language, which typically requires gender attribution, more than 20% of female scholars are incorrectly cited as if they were men. In all my samples, mistakes involving males being cited as if they were women are dramatically less frequent, suggesting that gender misattributions are strongly shaped by the gender-science stereotype. The gender of the citing author and the field of study appear to have only limited effect.

Keywords:
citations, gender-science stereotype

JEL:
A14, B54, J16

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Lies! Copernicus was a woman!
What? And Einstein?
Einstein was also a woman!
And maybe Curie-Skłodowska also?! Well, that wasn't the best example ...
Seksmisja (1983)

1 Intro

Numerous studies confirm that the social role of a scientist is strongly associated with the male gender (Steinke, Lapinski, Crocker, Zietsman-Thomas, Williams, Evergreen, and Kuchibhotla, 2007; Cvencek, Meltzoff, and Greenwald, 2011). While this is understandable in view of the dramatic gender disparity in the recorded history of science, the stereotype can prove harmful for the ever-increasing group of female researchers. Indeed, a woman involved in research or even dissemination of science can still cause a surprise. A spectacular example of that could be seen when Elise Andrew, using her newly created Twitter account, revealed herself to be the one behind the popular Facebook blog *I Fucking Love Science (IFLS)* (Holpuch, 2013). The effect was perhaps exacerbated by the profanity of the site's title and the language occasionally used there, which might have been perceived as more appropriate for a man. In any case, thousands of social media users expressed their shock or disbelief, often making comments signaling gender cliches.

If the specific instance of a woman-science combination represents a cognitive dissonance, two general strategies of dealing with it seem possible. First, one can come to believe that this is in fact no good science. For example, in what seems to be an interesting case of hindsight bias, a FB user named Pierre Rodriguez wrote "I had an intuition not to take the posts [of IFLS] seriously...". Much more importantly, some evidence has been found that women's academic work is evaluated systematically differently from that of men. For example, Budden, Tregenza, Aarssen, Koricheva, Leimu, and Lortie (2008) found that the introduction of a double-blind review process by Behavioral Ecology significantly increased the fraction of published papers that were first-authored by a woman. Such conclusions were, however, often questioned, e.g. Engqvist and Frommen (2008) failed to confirm a significant effect when applying a more rigorous statistical procedure. Likewise, in their review of much of this literature Ceci and Williams (2011) concluded there was no field evidence that discrimination against women by journals, job committees and granting bodies continues today. This line of research, however, is impeded by such issues as self-selection and difficulty in comparing research quality. To address these problems, some scholars have turned to controlled experiments. For example, Krawczyk and Smyk (2014) found that

same academic texts were judged as more publishable when the evaluators were told they had been written by a man rather than a woman (see also earlier experimental literature they cite.)

The other way out of the cognitive dissonance involves overlooking or ignoring the fact that the contributor is a woman in the first place. "Often, I will be standing in a group of men, and another person will come up and say hello to all the men and just will not see me, because in a professional setting, men are not programmed to see women" said Stanford neurobiologist Ben Barres quoted by Shankar(2006), recalling the times when he was still Barbara Barres. Likewise, some social media fans of IFLS commenting on the "newly revealed" identity of Elise Andrew noted that the blog host had in fact given interviews before and otherwise identified herself as a women. Yet, because these hints had been more subtle, generally speaking they had been conveniently overlooked by the audience. Until now, however, there seems to be no systematic evidence on this kind of refusal to recognize the identity of female scientists. This project is sought to fill in this gap.

Towards this end I look for instances, in which academic work was incorrectly cited, in that the gender of the author was misattributed. More specifically, I compare the cases in which a female author would be referred to as "he" to the cases where a male author would be referred to as "she". If a large, systematic difference in the prevalence of these two types of mistakes is found, it is proposed to be a manifestation of the adoption of the male-science stereotype by the citers. At the same time, such a practice reinforces the biased perception, in particular contributing to the lack of relevant role model perceived by female students and young researchers (Bettinger and Long, 2005). It may also adversely affect individual scholars, whose gender is misattributed, for it probably reduces their recognizability. In samples of master students, doctoral students and authors of published papers I find that female-turned-male mistakes are indeed much more common.

2 Relevant scientometric literature

The justification for the relevance of the research design in based on the following premises. First, being cited plays a tremendous role in developing an academic career, see e.g. the works listed in Bornmann and Daniel (2008). Second, giving credit to relevant sources is not the only motivation nurtured by researchers; in particular, social networks play a role: authors cite primarily works by authors with whom they are personally acquainted. (White, 2001). There is some evidence that gender stereotypes may affect such choices. For example Davenport and Snyder (1995) did observe that

women are cited less in the sociology journals they consider. This is not true of all studies, however, for example Borsuk, Budden, Leimu, Aarssen, and Lortie (2009); Ledin, Bornmann, Gannon, and Wallon (2007) found no such effect and Powell, Hassan, Dainty, and Carter (2009) reported the opposite. Again, studies in this strand of literature face serious methodological difficulties, primarily associated with attempts to control for quality of publications and base rates.

Third, studies such as Broadus (1983); Eichorn and Yankauer (1987) show that references in academic literature are surprisingly often incorrect, with estimates ranging between 10 and 60 percent (although of course most mistakes are minor). As Evans, Nadjari, and Burchell (1990) put it, "The data support the hypothesis that authors do not check their references or may not even read them" (p. 1353). As a result, it is common that credit is not given to the original source of the idea, e.g. because a review paper is cited instead (Teixeira, Thomaz, Michelan, Mormul, Meurer, Fasolli, and Silveira, 2013b). Altogether, it appears plausible that authors' genders do get misattributed sometimes, that it happens more often to female scholars and that it has some impact on their careers and the perception of the role of women in science in general.

3 Study 1

3.1 Design and procedures

In order to identify cases of gender misattribution I had to find a large number of citations of single-authored papers written by both males and females. Indeed, when citing multi-authored papers there is no need to identify *their* gender. Conversely, describing "*his* model", "*her* contribution" etc. the citer may be in err. The major obstacle in this kind of research is that bibliographic databases lack data on gender and number of authors. Additionally, papers written by one, female author are uncommon in many fields. To work around this problem I have used the following procedure. A list of the 10 most popular female names and the 10 most popular male names in the US as found in the 1990 census has been extracted from http://names.mongabay.com/. To be exact, the name Maria (#7) was replaced with Lisa (#11), because Maria is not an unusual (middle) name for males in some countries. Google scholar search query author:<first_name> (whereby <first_name> stands for any of the 20 male and female names under consideration) would then generally bring papers with *at least one* author of targeted gender, the problem being that vast majority of them would be multi-authored. To solve this problem I

have hypothesized that the phrase "the author" will be much more common in single-authored papers than in those with more authors. Using scholar google advanced options a research assistant unaware of the hypotheses of the study was asked to search, in each of the seven broad fields of science identified by the service (biology, life sciences, and environmental science; business, administration, finance, and economics; chemistry and materials science; engineering, computer science, and mathematics; medicine, pharmacology, and veterinary science; physics, astronomy, and planetary science; social sciences, arts, and humanities.) for *"the author" author:<first_name>*. In this way we were able to readily obtain a large number of highly-cited papers within given field that were authored by a single individual of given gender. On the results list we ignored:

1. papers with more than one author
2. papers authored by someone whose neither first nor middle name matched our query (typically this was because this person's *last* name did, in which case gender would have to be additionally verified)
3. individuals for whom likely gender was easy to identify without the given names, such as in the case of typically female double surnames, (Slavic-language) surnames that can only be female (Kowalska, Zhuravskaya etc.) or typically male suffices (Jr, III etc.)
4. papers with less than 100 citations

The exclusions 2 and 3 above were very rarely applied. For each paper that was verified as one that should not be ignored we have stored all the bibliographic details as well as the number of papers citing it.

As the next step we would search, within papers citing our publication of interest ("source"), for papers that seemed to misattribute gender of the cited author. In particular, for female authors, we would search for *"<last_name> AROUND(10) his" -"<first_name> <last_name>"*, for example, when the source was authored by Barbara Ronson, we would search for *"Ronson AROUND(10) his" -"Barbara Ronson"*. AROUND(10) is a proximity operator – it requires that the words "Ronson" and "his" come at most 10 words apart. The exclusion operator '-' ensures that the author's (here: Ronson's) *first* name is not mentioned in the paper – we reasoned it is highly unlikely that someone supposes that Barbara Ronson is a man. Within the results list we ignored, for obvious reasons, self-citations. Remaining papers were opened (whenever the full text copy was accessible) and instances of the <last_name> (here: Ronson) were looked for, until the (first) place where it

was indeed within 10 words of "his" could be found. We would then establish whether it referred to Ronson ("...in his study on widgets, Ronson (1998) used...) or not (...unlike Ronson (1998), Smith asked his subjects ...). In the former case, it was verified (by consulting the reference list) that the Ronson in question was indeed Barbara Ronson. We would call such a case "mistake"[1]

We would then repeat the procedure for the same cited paper, using the word "he" instead of "his". Obviously, for male names, we would search for "she" and "her". Additionally, because in all – so broadly defined – fields of study, papers written by a single male author are much more common than papers written by a single female author, we only took each fifth "male" paper satisfying the criteria (more exactly, we took the third, the eighth etc.). Once the number of mistakes for the cited paper was established, we would move to the next single-authored paper with at least 100 citations on our initial results list etc. When we run out of highly-cited papers (specifically, the entire results page of 30 hits contained no single-authored paper with at least 100 citations)[2], we would move to the next field of study, keeping the same first name. Once we run out of fields of study, we would move to the next name etc.

To make sure that learning or boredom or whatever other time effects do not affect the results, I asked the research assistants to start with female #1 name, then do male names #1 and #2, then female names #2 and #3 etc. The ordering of fields of study was also alternated.

In order to investigate the impact of gender of the citing author on probability of misattribution, we have classified several *citing* papers as either male-authored (one or more male authors, no female authors), female-authored or mixed.[3] We did that for all the papers that cited a paper that was associated with at least one mistake and attributed gender to its author, no matter whether it was correct or incorrect attribution. E.g. if at least one author citing Barbara Ronson's 1998 paper implied that she was a he, we would additionally search within papers citing Ronson's paper for "Ronson AROUND(10) she" and "Ronson AROUND(10) her". In this way the set

[1]For all safety, we have verified using google image search, personal websites, wikipedia entries etc. for all authors with at least one mistake that their gender indeed was as their given names would suggest it was (in our example – that Barbara Ronson was indeed a woman.)

[2]The number of citations is a very important criterion taken into account by scholar.google in determining the order of hits. Nevertheless, it is possible that some papers with more than 100 citations may have been overlooked in this way.

[3]This procedure was highly time-consuming, thus we decided not to apply it to every citing author.

of papers with some gender attribution was precisely determined and within this set we determined the gender of the authors. We thus knew how many female, male or mixed teams attributed gender correctly. Obviously, we also stored gender of authors that have actually misattributed. Additionally, we would do the same for 12 randomly chosen papers in each field of study, whose authors' gender was *not* misattributed.[4]

On the basis of literature reviewed before I hypothesized that female scholars will have their gender misattributed more often than males and that the effect will be will be highest in older publications. Further interesting interesting research questions concern the gender of the citer. We may speculate that males and researchers in male-dominated fields may misattribute females' gender most often.

3.2 Results

For the exposition, I have collapsed the seven fields into four "broad fields" (see table below – broad fields 1 and 3 are composite) because we have few observations in physics, chemistry and engineering as well as biological and medical sciences (of course, these are not narrow fields in terms of total number of papers but they tend to have few single-authored papers and few female authors). This particular way of collapsing the fields has been dictated by intuitive similarity of the narrow fields in question and statistics at the level of "narrow" fields – there are little differences within each broad field.

Several remarks can be made at this point. First, prevalence of gender misattribution is quite low. Overall, of the 2893 sources checked, authors of but 57 (1.97%) have been subject to gender misattribution (there were 66 mistakes in total, because some papers have been incorrectly cited more than once). Second, the disproportion between genders is striking: I only found four male-turned-female mistakes (concerning three papers). For females, as many as 53 papers (4.65%) are at least once miscited. Given that there are ca. 4 gender attributions per source paper in our sample, 1.16% of all attributions of single female authors turn out to be incorrect, whereas the rate for males is .04%. Third, it appears that there is an effect of the field of study – female-turned-male mistakes are most common in biz and econ, then social sciences, arts and humanities and essentially never happen in bio/med.

The last effect begs two questions. First, could it be explained simply by the fact that authors of bio/med publications do not attribute any gender at all to authors of cited papers? It turns out it cannot. For example the number of total correct attributions in bio/med is quite comparable to that

[4]Repeating this procedure for all the citing papers would be infeasible.

Table 1: Number of papers, whose authors' gender misattributed at least once, by gender and broad field of study

	author	
broad field	male	female
bio/med	0	1
	(283)	(133)
biz, econ	1	15
	(340)	(197)
phys/chem/engi	0	7
	(652)	(102)
social sc, arts, hum	2	30
	(478)	(708)

The total number of citable papers checked is given in the parentheses. For example, just one out of 133 highly-cited female-authored papers in biomedical research has been subject to gender misattribution.

of biz and econ (2.57 vs. 2.92).

Second, is the effect significant? To answer this question, a simple probit regression was run, see Table 2.[5]

Table 2: Impact of field of study, publication year and number of citations on probability of misattribution – probit analysis.

mistake	Coef.	Std. Err.	z	$P > \|z\|$	[95% Conf.	Interval]
broad field:						
biz, econ	.905	.387	2.34	0.019	.147	1.663
phys./chem./engi.	.867	.410	2.11	0.035	.063	1.671
social sc., arts, hum.	.636	.372	1.71	0.087	-.0920	1.365
citations	.0011	.0003	3.57	0.000	.0005	.002
citations_squared	-1.99e-07	9.43e-08	-2.10	0.035	-3.83e-07	-1.37e-08
year	.004	.005	0.69	0.489	-.007	.014
cons	-10.427	11.167	-0.93	0.350	-32.314	11.460
N	1139					

[5]Again, the independent variable is a dummy indicating whether there is at least one misattribution for given source paper or not. In other words, I do not distinguish here between papers whose authors' gender has been misattributted once and those for which it happened more than once (which makes no difference anyway because there are just six papers in the last group).

Thus, compared to the base category of bio/med, mistakes are more common in biz/econ as well as in physics, chemistry or engineering and only weakly more common in social sciences, arts and humanities. While establishing the fraction of female authors in such fields is quite difficult, one can probably safely bet that it highest in the (intermediate) category of arts and humanities; there thus seems to be no straightforward relationship between visibility of females in the field and prevalence of mistakes. Also the number of citations turns out to exert a significant and non-linear effect. The values of coefficients correspond to intuitive predictions – if given paper is cited a lot, a larger number of citers have a chance to make a mistake (strongly significant positive coefficient on "citations"). On the other hand, if the paper is truly famous, then it is likely that its author is widely known as well, so that few researchers will get the gender wrong (negative coefficient on citations_squared). Note also that, contrary to the hypothesis, there is no effect of the year in which the source was published.

3.2.1 Impact of gender of the citing author

Table 3 shows the female-to-male misattributions broken by the gender of the citing author. Contrary to the hypotheses, gender of the citer has no impact on the prevalence of misattributions.

Table 3: Attributions and mistakes by gender

broad field	fem. mist.	fem. attr.	male mist.	male attr.	mix. mist.	mix. attr.
bio/med	1	4	0	7	0	3
biz, econ	4	37	8	102	4	32
phys/chem/engi	1	22	5	70	5	21
s. sc, arts, hum.	12	168	15	133	7	83
Total	18	231	28	312	16	139

Only female sources misattributed at least once are considered. For example, 32 mixed teams made some attributions of authors of business papers that were misattributed at least once. Of these 32, four attributions were incorrect.

Study 1 showed that overall few gender misattributions are made. However, this is mostly because there is rarely a need to make an attribution in the first place, so presumably authors who choose to do so tend to be those, who are quite confident they get it right. Indeed, many of them may simply know the cited author personally. Moreover, research assistants, referees, editors and proofreaders likely succesfully deal with most remaining problems. In this sense, our estimates that more than 1 in 100 gender-specific citations

of women are incorrec (compared to essentially zero for male authors) do not seem that low.

4 Study 2

4.1 Design and procedures

As stated before, a major difficulty in Study 1 was that the gender was only rarely attributed at all in that sample. A feature of English grammar, this is not true of all languages. In Polish (and several other Slavic languages), grammar forms depend on the gender of the noun. If an author wishes to express the idea that, say "Smith (2005) used the data collected by Jones (1998)" in the English language, it does not matter whether Smith and Jones are male or female. Conversely, in the Polish language, the four possible cases will result in four slightly different sentences: "Smith (2005) skorzystała z danych zebranych przez Jones/Jonesa (1998)". Inevitably, gender attributions are dramatically more common.

On the minus side, the overall amount of academic literature in any Slavic language is much smaller than that of English. Moreover, many journals are not easily available in the digital form. To obtain a large corpus of texts to verify our hypothesis I have thus decided to turn to master and doctoral theses.

Because, as mentioned before, gender can be attributed in a number of ways in the Polish language and because theses are typically not included in bibliographic databases, a different search strategy than that of Study 1 had to be employed.

The specific choice of the sample was dictated by access to the (Polish-language) theses, typical number of citations per thesis and fraction of female authors. In the end, it turned out that only social sciences, particularly psychology could be of practical use for my purposes. I have thus taken a sample of 120 recent Polish-language master theses defended at the Faculty of Psychology, University of Warsaw or the Institute of Psychology, Cardinal Stefan Wyszynski University in Warsaw (UKSW). The former offers the best psychology curriculum in Poland (perhaps et par with the Institute of Psychology at the Jagiellonian University of Cracow), while UKSW is less prestigious. The sample was random, except that male students were oversampled, because they are considerably less numerous in this curriculum. On top of that, 38 doctoral dissertations in social sciences available in the University of Warsaw repository were used.

The number of source texts was thus much smaller than in the first study,

which was associated with limited access, much longer time necessary to deal with any of them and much higher average number of attributions expected.

A research assistant blind to the purpose of the study was asked to browse the entire thesis searching for citations. Those containing the first name of the cited author and those for which the last name immediately identified gender (esp. Polish -ski/ska names) were ignored. For the remaining cases it was established if the author of the thesis implicitly attributed gender by

1. inflecting the surname (e.g. "Johnsona" (Johnson's) is the correct form if and only if Johnson is male)
2. using gender-specific verb form (e.g. "Kozak wykazała" (Kozak proved/showed) indicates that Kozak is female; in the case of multi-authored papers it could only be established whether the student implied that at all authors were female or that at least one was male)
3. using a pronoun (on(a), jej/jego – (s)he, his/her)
4. using a gender-specific noun (e.g. autor(ka) refers to a (fe)male author)

The first manner of gender attribution was the most common, while the latter was hardly helpful. It was also found in the course of the study that some students failed to inflect any surname of a cited author. While this is bad grammar practice, it is sometimes followed because declension of foreign surnames is widely considered troublesome and some erroneously believe that these should better not be inflected at all. Gender attributions based on uninflected surnames in such theses were discarded.

A passage containing any alleged gender attribution was copied to the spreadsheet so that I could later verify it. The research assistant also recorded the attributed and actual gender of the cited author, using Internet sources for the latter (typically researcher's home page).

4.2 Results

Figures 1 and 2 show the fraction of citations in which gender was misattributed (one attribution being treated as one observation), separately for all four combinations of gender of the citing and cited author, in the master theses and dissertations. Males are inadvertently cited as females only infrequently and the prevalence of such a mistake does not depend on the gender of the student. By contrast, it is very common for master students, especially males, to misattribute gender of female scholars.

For the doctoral dissertations the mistakes are generally less common, which probably has to do with positive selection of more careful authors and

their better acquaintance with the literature of the field, acquired during a much longer period of working on the dissertation. The doctoral candidates are also much more likely to know some of the cited authors personally, or at least to have visited their websites, consulted their biographies etc. Other than that, the patterns are quite similar, with female-into-male misattributions being far more common. In this sample we see much less evidence of the impact of the gender of the student.

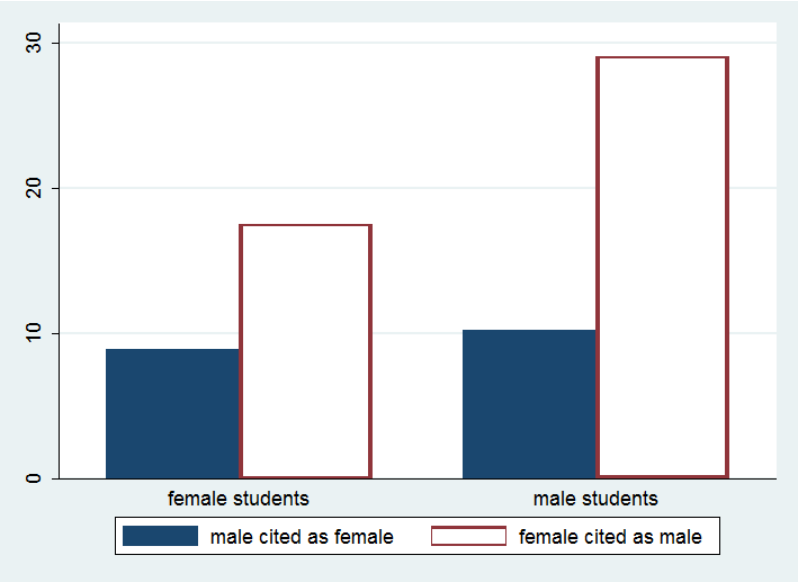

Figure 1: Prevalence of misattributions in master theses, in percent (n=1553)

Of course, such a pattern could result from a small group of (mostly male) students incorrectly citing many female scholars. To put this finding to a conservative statistical test, I have calculated student-specific indices as (number of females-turned-males mistakes)/(numbers of correct attributions of female gender) and likewise for male scholars. In other words, I consider each thesis as one independent observation only. In line with Figure 1, I find that male-turned-female mistakes are equally common among male and female master students. However, male students are marginally more likely to 'turn' female scholars into males ($p = .036$ in a t-test and $p = .086$ in the non-parametric ranksum test, which is more appropriate in view of non-normal distribution of the variable in question). As explained before, male-turned-female mistakes, but not the other type, could result from neglect of grammar rules. The observed pattern can thus be explained rather in terms of male students being more affected by the gender-science stereotype than any gender being more or less careful with grammar. No difference was found

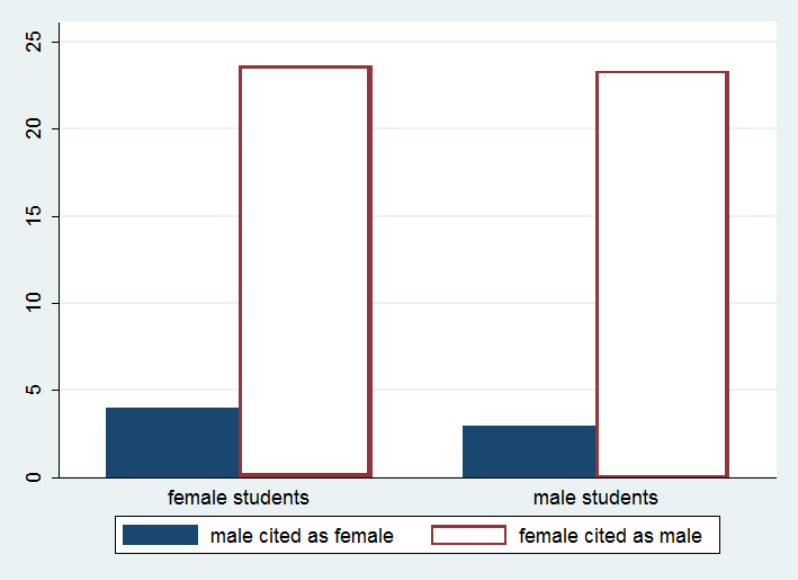

Figure 2: Prevalence of misattributions in doctoral dissertations, in percent (n=995)

for doctoral students. There were also no significant effects of the field of study, school, and gender of the advisor.

5 Summary and conclusions

The studies reported here used very different samples and search approaches. Consequently, overall prevalence rates observed were vastly different: misatributions were very common in master students, less common in more advanced doctoral students and rare among professional scholars (writing in English, so rarely having to attribute gender in the first place). Also, the gender of the authors seemed to play a role in the first of these three groups only. However, the main finding that females are much more often incorrectly cited as if they were male than vice versa seems to be robust across samples.

The plausible explanation is that the gender-science cliche remains strong in (some) authors, so that they do not feel the need to check. Hopefully, with more females reaching high academic positions and publishing successfully, also in traditionally male-dominated fields, the tendency will come to an end. For instance, the Fields Medal being awarded to a woman, Maryam Mirzakhani, for the first time in 2014, may help prove beliefs that "girls can't do math" wrong. By contrast, individual female researchers' understandable unwillingness to emphasize their gender, may slow down the pro-

cess. Indeed, interestingly, one of the female academics that were miscited as men in my sample was Dorothy Bishop, who only uses gender-neutral initials D.V.S. to avoid prejudice against women, see `http://www.ncl.ac.uk/congregations/assets/documents/dorothybishop.pdf`. On the bright side, the prevalence of gender misattributions among professional scholars is low. In this sense, these mistakes per se probably do not significantly contribute to lower awareness of female researchers' achievements.

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