Problems associated with authorship of scientific publications: coauthorship dissatisfaction index

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Abstract

Increasing levels of collaboration constitute one of the characteristics of science. However, the knowledge production system is based on a fundamental discordance: on the one hand, it is cooperative in nature, with links articulated through coauthorships, and on the other, the systems for assigning merit and distributing rewards function on an individual scale. This contradiction can give rise to dysfunction and mala praxis.

This study analyzes researchers' perceptions about the problems associated with authorship in scientific publications. We propose a coauthorship dissatisfaction index that measures the degree of dissatisfaction with the author order on the byline, ghost authors, and hyperauthorship. There are differences in this regard according to the branch of knowledge, status in the academic hierarchy, and sex. Using a sample of 2344 researchers, we observed an overall dissatisfaction rate of 12.4%. The highest rates were in the areas of Health Sciences and Social Sciences, in early-stage career academics, and in women. The cognizant authorities should take steps to regulate authorship, tailoring rules to each area of knowledge, with an eye toward reducing discrimination, gender bias, and abuse of authority.

Keywords: Co-authorship, research collaboration, scientific misbehavior.

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1. Introduction

The number of authors who collaborate on scientific publications is continuously rising in all areas of knowledge (Drenth 1998; Glanzel 2001; Weeks et al. 2004; Levskey et al. 2007; O'Brian 2012; Henriksen 2016; Kuld and Hagan 2018). It is broadly recognized in the literature that the increase in research papers signed by more than one author is directly correlated with collaboration (Endersby 1996; Babchuk et al. 1999; Godin and Gingras 2000; Wagner-Döbler 2001¸ Wuchty et al. 2007; Gazni and Didegah 2011). The recognition obtained from authorship of a scientific publication is a key element of how science works. Collaboration produces benefits and advantages for researchers, the organizations they are affiliated with, and even for science as an institution.

However, coauthorships can also give rise to unethical and deceptive practices, which some junior researchers perceive as potentially the most frustrating problem related to working in their academic communities (Currie 1997). Although these problems have been identified in the literature, there is little data about their incidence in different scientific areas or according to researchers' academic positions or sex. This study aims to start filling that gap.

The increase in collaborative scientific collaboration has been a characteristic feature of the evolution of science since at least the beginning of the 20th century (Price 1963; Beaver and Rosen 1978; Wagner-Döbler 2001). Numerous factors and causes are behind this trend. Beaver and Rosen (1978) were among the first to study scientific collaboration, attributing its growth mainly to the professionalization of science. Katz and Martin (1997) identified several heterogeneous factors in their study of this general process, describing researchers' need to seek or share financial and material resources (e.g. research equipment or samples) as well as specific knowledge and skills (Nedeva et al. 1999; Lee and Bozeman 2005). Professionalization and collaboration have also been associated with symbolic benefits such as prestige or recognition (Hara et al. 2003; Bozeman and Youtie 2016). Furthermore, collaborative projects have served as a chrysalis for transmitting knowledge and learning information about the profession, and it is closely related to training and mentoring (Crane 1972; Etzkowitz 1992, Bozeman and Corley 2004). Finally, institutions and public administrations have incentivized collaboration (Cummings and Kiesler 2005), and modern information and communication technologies—together with researcher mobility and academic exchanges—have facilitated it (Hesse et al. 1993; Kouzes et al. 1996; Finholt 2002; Sooryamoorthy, and Shrum 2007; Ding et al. 2010).

The collaboration-coauthorship combination produces several positive effects. Since Lotka (1926) first reported on the degrees of productivity among researchers, some authors have determined that these differences are partly due to collaborative research practices (Price and Beaver 1966; Zuckerman 1967; Beaver and Rosen 1978; Lee and

Bozeman 2005). Other studies have noted the greater visibility and impact (as measured by the citations received) of publications signed in coauthorship (Price and Beaver 1966; Bordons et al. 1996; Lee and Bozeman 2005; Narin et al. 1991; Katz and Hicks 1997; Persson et al. 2004; Lee and Bozeman 2005; Wuchty et al. 2007; Gaughan and Ponomariov 2008). Collaborative projects also appear to attract more funding (Heffner 1981). It is even possible to discern a certain positive feedback loop, with scientific collaboration representing a self-fulfilling prophecy (Merton 1948). The identification and perception of the positive effects of collaboration feeds into the phenomenon, boosting researchers' inclinations to work together on publications.

However, collaboration and coauthorship are not exempt from problems, conflicts and dysfunction. Bozeman et al. (2013) used the term "the dark side of collaboration research" to describe this other reality. Some of the most frequent problems are unmerited authorships or honors, which consist of excessive levels of coauthorship or, using the term coined by Cronin (2001:558), "hyperauthorship." "Ghost authorships", where the author list omits relevant contributors to the study, are also an issue, as are disputes related to the order of authors on the paper's byline.

These problems have been identified and sometimes reported, and different measures have been proposed to reduce them; however, few efforts have been made to quantify the incidence of different problems or to describe researchers' perspectives according to variables like scientific area, professional category, and sex. The aim of this study is to provide empirical evidence to fill this gap in knowledge, based on a survey of 2344 academic researchers in universities of the Valencian Region (Spain).

2. Literature review and hypothesis

2.1. Problems of coauthorship

The increase in publications of collaborative scientific articles has given rise to different conflicts and problems related to authorship, some of which constitute cases of mala praxis. These conflicts and problems have been studied since the 1960s, and academic institutions, scientific societies, and journal editors have consequently adopted formal measures to determine authorship, recognize contributions, and assign credit. Some of the most widely adopted and well-known guidelines are those produced by the International Committee of Medical Journal Editors (ICMJE, or the Vancouver Group), which were first released in 1979 and have been periodically updated since then. However, the problems and conflicts around authorship have proven quite resistant to these initiatives. Some authors argue that the problems may even be getting worse (Wilcox 1998; Bennett and Taylor 2003; Sismondo 2009), although the only longitudinal studies, performed in 1996 (Flanagin et al. 1998) and 2008 (Wislar et al. 2011), have reported the opposite trend, that is, a decrease in honorary and ghost authorships.

The literature includes studies identifying and analyzing authorship conflicts, which fall into three categories: author order, exclusion of authors making substantive contributions to the research on the author list, and inclusion of authors who did not participate in the research at all or at least in a way that would justify their inclusion (Rennie and Flanagin 1994). In more recent years, other behaviors constituting mala praxis have come to light, such as the professionalized role of writers commissioned to draft the paper despite not being part of the research (Lagnado 2003) or the inclusion of an author on a high-impact paper in exchange for payment (Hvistendahl 2013). In some way, these new forms of including authors who have not participated in the research could be denominated as guest authorship.

The problems related to coauthorships occur in the context of maladjustments between the three scientific subsystems related to authorship. Although they are sequentially connected, they function with their own rules and practices. They include: (i) the system of collaborative scientific knowledge production; (ii) the publication of results; and (iii) the assignment of rewards and recognition. Reflections on this disconnect have prompted efforts to clarify the concept of scientific authorship and to propose alternative forms for approaching it, for example using the term "contributors" based on the differentiation between credit, recognition and contribution (Rennie and Yank 1997, 1998; Smith 1997a, 1997b; Birnholtz 2006; Biagoli 1998, 1999; Osborne and Holland 2009). Other authors also point to the pitfalls of applying an idealized concept of authorship to changing scientific practices (Croll 1984; Laudel 2002; Ponomariov and Boardman 2016; Larivière et al. 2016).

2.1.1. Author order

Disagreements and disputes about the order of authors on scientific publications was one of the first problems to be addressed. The general principle assumed in scientific fields is that author order is important, expressing different meanings and producing different effects. The position of the authors on the byline should reflect their participation on the paper—not their academic position—with the first author having made the largest contribution (Riesenberg and Lundberg 1990). However, in the late 1960s, Zuckerman (1968) showed the variability in uses (and therefore significance) in the author order in publications on which Nobel laureates had participated. The variations between areas of knowledge are decreasing, but there are still some disciplines and journals that prefer authors to appear in alphabetical order, a practice in decline (West et al. 2013).

When there are several authors, the order is not alphabetical. Rather, conventions have stabilized around the recognition that author order should be based on contribution to the paper, with the first author receiving the most credit and recognition, followed by the others in order of appearance. The exception is the last author, who also has an

important position in some disciplines; this place is reserved for the author with the highest rank on the academic hierarchy (Bayer and Smart 1991; Fine and Kurdeck 1993; Shapiro et al. 1994; Lariviere et al. 2016). Nevertheless, Shapiro et al. (1994) found that the descending order of signatures based on contributions is not generally followed. Some studies have found that the author order on a paper is perceived as inappropriate in as many as 23% of cases (Bhopal et al. 1997). Different reports have also shown that academic rank is an important influence in this respect, as are the strategies for career promotions that some researchers apply (Burman 1982; Hart 2000; Drenth 1998; Costas and Bordons 2011; Bozeman and Youtie 2016) and gender (Wilkie and Allen 1975; Moya-Anegón et al. 2004; Ghiasi et al. 2018).

2.1.2. Subauthorship, ghost authorship, and guest authorships

A second problem area in coauthorships has to do with the exclusion or inclusion of authors: excluding people who collaborated in the research process and/or including those whose contribution is insufficient to justify authorship or absent altogether.

The first attempt to approach this phenomenon was based on what Patel (1973) called "subauthorship," generally the recognition of an author's contribution only in the acknowledgements. In principle, subauthorship is not a problem of authorship itself, and it was not analyzed as such (Hagstrom 1965; MacKenzie 1972; Patel 1973) until Heffner (1979). This author was the among the first researchers to note the conspicuous absence of graduate students, lab technicians, other junior participants, and especially women in the author lists; recognition of their contributions would be relegated to the acknowledgements. Subauthorship can be a subtle form of exclusion (Cronin 1992) but also inclusion; in the latter case, a kind of honorary authorship or minor gift. In the case of author order, some subauthorships reflect the academic hierarchy rather than authorship criteria (Yank and Rennie 1999).

This also occurs in cases of exclusion or unmerited inclusion of authors, the two types of coauthorship misbehavior that have attracted the most attention. In the first case, the inclusion of authors who have contributed little to no work or who do not meet the criteria of authorship, can be described in a variety of ways: "honorary", "gift", "gratuitous," "guest," and "token" (Croll 1984; Rennie and Flanagin 1994; Bozeman and Youtie 2015; Currie 1997). While these manifestations are diverse in form, they are similar in substance (Rajasekaran et al. 2015). In the second case, the omission of authors who have made substantive contributions from the paper's byline, the term "ghost" has been used (Rennie and Flanagin 1994; Bozeman and Youtie 2015). As both the inappropriate exclusion and inclusion of authors are quite common, there are abundant references in the literature that have aimed to quantify the phenomenon, either based on authors' and researchers' perceptions and knowledge or based on criteria for authorship—usually from the ICMJE.

In one of the first studies performed on the topic, focusing on psychology (Vasta 1981), 28% of respondents reported having personally been involved in situations in which authorship did not reflect the real contributions of participants. Slone (1996) found that the percentage of undeserved authors exceeded 9% in papers signed by three authors and 30% in those signed by more than six. Moreover, there was a higher probability of including an undeserved author in papers led by nontenured staff members (45%) compared to tenured faculty. For their part, Bhopal et al. (1997) elicited testimonies from 66 staff members of a university medical school, finding that 38% knew of undeserved authorships and 48% of omitted contributors. Flanagin et al. (1998) contacted corresponding authors from six medical journals, finding that 19.3% of the publications had an honorary author and 11.5% a ghost author. Yank and Rennie (1999) checked the authorships listed in *The Lancet* from July to December 1997 against the ICMJE criteria, finding that 44% of the authors did not meet those requirements. In the same line, Mowatt et al. (2002), surveying the corresponding authors of reviews included in the Cochrane Library, found a 39% rate of honorary authorships and 9% of ghost authorships. Marusic et al. (2004) studied authorship contributions in a modest medical journal, finding that just 40% of the authorships complied with ICMJE criteria. The authors most likely to meet these criteria were the first ones listed on the byline, but the more authors were listed, the less appropriate the author attributions were.

In the field of biosciences, Martinson et al. (2005) reported that 10% of authorships among early- and mid-career scientists were inappropriate. Pignatelli et al. (2005) carried out 37 in-depth interviews among principal investigators in biomedicine, discovering that 59% had received gift authorships and 64% knew of ghost authorships. Eisenberg et al. (2011) reported a rate of 26% inappropriate authorships in the journal *Radiology and European Radiology,* although this figure rose to 58.9% if the authorships were checked against the ICMJE criteria. Wislar et al. (2011) found a rate of 17.6% of honorary authorships and 7.9% for ghost authorship in six prestigious medical journals, while Bonekamp et al. (2012) reported a 24.7% rate of gift authorships in the *American Journal of Roentgenology*, which rose to 57.6% if one or more of the coauthors failed to fulfill ICMJE criteria. In three radiology journals, Eisenberg et al. (2014) determined that the perceived rate of honorary authorships was 27.7%, but against the ICMJE criteria it was 50.3%. Rajasekaran et al. (2014) looked at three major physical medicine and rehabilitation journals, finding that the rate of perceived undeserved authorship was 18.0%, and the ICMJE-defined undeserved authorship rate, 55.2%. For Shah et al. (2018), the prevalence of perceived hyperauthorship was 20.9%; against ICMJE criteria, it was 60%. Finally, in the study by Al-Herz et al. (2018), a third of respondents (33.4%) admitted they had added people to the author list who did deserve credit as such. Overall, then, honorary/undeserved authorships occur at a rate ranging from 10% to 60% over a diverse range of studies.

2.2. Hypothesis

Although the problems associated with authorship in scientific publications have been established, along with their incidence, the reasons and the possible causes, a structural vision is still lacking. Moreover, there are few data about the distribution of these problems by scientific area or their incidence according to two relevant variables: professional category and sex. We have formulated three hypotheses around these variables.

Despite the universal spirit of science, there are important differences between disciplines in terms of how they operate and their norms, ways of thinking, communication, organization, need for economic and material resources, social prestige, and closeness of ties with social or business organizations (Shin 1982; Cole 1983; Newman 2001). In the case of coauthorships, Lariviere et al. (2016) found different patterns related to the division of labor, so the subsequent attribution of authorship responds to different traditions. Assuming that relevant differences exist between disciplines, our first hypothesis is that:

> H_1 Scientific researchers in different fields have different levels of dissatisfaction related to coauthored publications.

Secondly, the study of science is characterized by stratified positions, hierarchies and power structures, which hinge on researchers' academic posts, prestige, recognition, and material and human resources (Cole and Cole 1973; Bourdieu 1975; Whitley 1985). Given that these benefits and rewards are conceded largely based on authorship attributions, we hypothesized that:

> H_2 Dissatisfaction with the publications carried out in coauthorship is negatively correlated with rank in the academic hierarchy.

Finally, and in relation to the previous hypothesis, we supposed that not only internal hierarchies within a given field—but also structural inequalities in society—would affect authorship attributions, and these inequalities would be reproduced in the field of academia. One such type of inequality is that related to gender (Cole and Cole 1973; Zuckerman and Cole 1975; Kohlstedt 1978; Rossiter 1982, 1993; Harding 1986; Abir-Am and Outram 1989), and this is clearly reflected in scientific collaboration and publications (Cole and Zuckerman 1984; Bozeman and Gaughan 2011). Thus, our third hypothesis was that:

> H_3 Female scientists experience greater levels of dissatisfaction than men with regard to publications produced in coauthorship, even after controlling for variables of hierarchy and academic field.

3. Materials and methods

This section describes the study design and analytical methods used to test our hypotheses, the instruments and processes employed to collect data, and the coauthorship dissatisfaction index and statistical analyses implemented to obtain our results.

3.1. Instrument

This study builds on the results of a broader investigation on scientific collaboration practices in the Valencian Region of Spain (González-Alcaide y Gómez-Ferri, 2017). We used a 24-item questionnaire eliciting information on the degree of collaboration, its forms and dimensions, the motivations behind it, strategies applied, and the publication process. The development of the questionnaire was based on a literature review of the main studies on scientific collaboration. The survey also included items on the area of knowledge and diverse variables for classifying researchers, including academic position and sex.

3.2. Coauthorship dissatisfaction index

To perform the present study we developed an index to measure dissatisfaction with scientific collaboration based on three variables collected in the questionnaire: the reflection of researchers' contribution on the paper's byline, the appropriateness of the order of signatures, and the existence of unjustified hyperauthorships. Variables were dichotomous, with one point assigned to each item where a problem was identified. Thus, the index ranged from 0 to 3, with the higher scores showing higher dissatisfaction with scientific collaborations.

3.3. Field work

The survey was sent by email to all faculty and research staff members of the five public universities, and two of the four private universities, in the Valencian Region, a total population of 12,406 (González-Alcaide and Gómez-Ferri, 2017: 28). The email explained the aims of the study and assured respondents of the confidentiality of their answers. Email addresses were obtained from university staff directories. In addition to the initial invitation, we sent two personalized reminders containing a link to the questionnaire.

The field work took place from March to May 2016. We also performed continuous follow-up to foster participation among the universities and professional categories where response rates were below the desired levels.

3. 4. Sample

A total of 2344 people (18.9%) responded to the questionnaire. Table 1 shows the distribution of response rates and the sampling errors for each area of knowledge, had the sampling strategy been randomized. Sample sizes from the areas of Arts and Humanities, Exact Sciences, Health Sciences, and Engineering represented upwards of 20% of the totals, and the corresponding sampling errors were not more than ±4.5%. In the case of Social Sciences, the fraction of the total population that responded was lower, at 15.6%; however, due to the high absolute number of responses (n = 582), the sampling error in this area was the lowest we calculated.

Table 1. Distribution of responses by universities and areas of knowledge

University	Arts and Humanities	Exact Sciences	Health Sciences	Social Sciences	Engineering
University of Alicante	105	132	58	195	78
University Jaume I	70	68	74	79	65
Miguel Hernández	14	46	83	38	44
Polytechnic University of	75	100	15	64	401
University of Valencia	165	190	249	330	27
University Cardenal	10	7	48	11	6
Catholic University of	18	14	58	29	1
Total responses	345	488	470	582	459
Total population	1240	1928	1535	3765	2347
Response rate	27.8%	25.3 %	30.6%	15.6%	19.6%
Sampling error	±4.5%	±3.8%	±3.8%	±3.7%	±4.1%

3. 5. Statistical analysis techniques

We applied one-way analysis of variance (ANOVA), Tukey's test, and the student's *t* test to analyze differences in means between independent samples, along with linear regression analysis. ANOVA and Tukey's tests were used to identify the existence of significant differences in the coauthorship dissatisfaction index according to area of knowledge and professional category, while the student's *t* test was used to test differences according to gender. Finally, we used linear regression to simultaneously consider the influence of professional category, area of knowledge, and gender on the coauthorship dissatisfaction index.

4. RESULTS

To test our research hypotheses, we performed various statistical tests based on three variables, measuring whether there were situations in which the respondent's contribution was not captured as a coauthor, the order of signatures was not

appropriate, or there was an unjustified hyperauthorship where someone was recognized as an author without having contributed to the paper.

As the results included in table 2 show, these situations affected 4.7%, 5.4% and 8.7% of the respondents, respectively. Overall, 12.4% of the sample admitted to having been involved in at least one of these three problematic situations.

Table 2. Itemized distribution of variables included on the coauthorship dissatisfaction index

	Yes	**No**	**Total**
Contribution not reflected as authorship	4.7%	95.3%	100%
Inappropriate order of signatures	5.4%	94.6%	100%
Existence of unjustified hyperauthorship(s)	8.7%	91.3%	100%
Involved in at least one of the above	12.4%	87.6%	100%

Given that the three variables are dichotomous, one point was assigned to every 'yes' answer on the coauthorship dissatisfaction index, for a total score ranging from 0 to 3. Table 3 shows the mean scores according to respondents' area of knowledge, professional category, and sex. The highest mean values were in respondents working in the areas of Health and Social Sciences, in the positions of associate professor and assistant professor, and in women. In contrast, senior professors and faculty and research staff in the area of Arts and Humanities showed the lowest dissatisfaction.

Table 3. Descriptive statistics for the coauthorship dissatisfaction index

		N	**Mean**	**SD**
Area of knowledge	Arts and Humanities	345	0.12	0.411
	Exact Sciences	488	0.14	0.462
	Engineering	459	0.17	0.540
	Social Sciences	582	0.23	0.615
	Health Sciences	470	0.25	0.667
Professional category	Senior professor	384	0.08	0.326
	Professor	721	0.17	0.500
	Associate professor	255	0.22	0.592
	Assistant professor	180	0.29	0.722
	Adjunct	335	0.27	0.681
	Other professional	469	0.19	0.587
Sex	Men	1400	0.15	0.489
	Women	944	0.24	0.642

SD: standard deviation.

* Other professional figures include collaborating, emeritus and visiting professors; graduate and postgraduate research fellows; technical officers; and other miscellaneous professional categories.

The results presented in tables 4 and 5 respond to H_1, which hypothesized that there would be differences in coauthorship dissatisfaction according to respondents' area of knowledge. Specifically, we speculated that coauthorship dissatisfaction would be higher in the areas with less tradition of coauthorship or recent and pronounced growth in collaboration. This would be the case for the areas of Health and Social Sciences.

To test the hypothesis, we performed a one-way ANOVA test, using the dissatisfaction index as a dependent variable and the five areas of knowledge (Art, Exact Sciences, Health Sciences, Social Sciences, and Engineering) as the grouping variable. The analysis confirmed (table 4) that the difference in means between areas of knowledge were statistically significant (F = 4.469; $p < 0.01$). The scores registered in Health Sciences and Social Sciences were statistically higher than in other areas, proving H_1 to be correct.

Table 4. One-way ANOVA according to area of knowledge

	Sum of squares	**df**	**MS**	**F**	***p* value**
Between groups	5.533	4	1.383	4.469	0.001**
Within groups	723.874	2339	0.309		
Total	729.406	2343			

df: degrees of freedom; MS: mean squares.
** = $p < 0.01$

The multiple comparison test (Tukey's Honest Significant Difference), whose results are shown in table 4, reveal that the mean value obtained in the area of Health Sciences—the highest in the study—is significantly higher than in the areas of Arts and Humanities and Exact Sciences, where values are the lowest. Scores in the Social Sciences were also significantly higher than in Arts and Humanities, although they were not significantly different from the other areas. These results reinforce the validity of H_1, confirming a higher level of perceived problems in the areas of Health and Social Sciences.

Table 5. Tukey's test according to area of knowledge

	Arts and Humanities	**Exact Sciences**	**Health Sciences**	**Social Sciences**	**Engineering**
Arts and	1.000				
Exact Sciences	0.970 ns	1.000			
Health Sciences	0.006 **	0.019 *	1.000		
Social Sciences	0.040 *	0.118 ns	0.926	1.000	

Engineering	0.664 ns	0.933 ns	0.172 ns	0.546 ns	1.000

** = $p < 0.01$; * = $p < 0.05$; ns = non-significant

The analyses carried out to test H_2 followed the same sequence and are based on the same statistical techniques used to test H_1. In this case, the dependent variable was still the coauthorship dissatisfaction index, but the grouping variable was the respondent's professional category. The means included above in table 3 showed that dissatisfaction was higher in respondents with lower professional categories, with the highest dissatisfaction in assistant and adjunct professors. The ANOVA shown in table 6 confirms H_2, in that coauthorship dissatisfaction increased as professional status decreased.

Table 6. One-way ANOVA according to professional category

	Sum of squares	**df**	**MS**	**F**	***p* value**
Between groups	9.936	4	2.484	8.323	< 0.001 **
Within groups	558.104	1870	0.298		
Total	568.039	1874			

df: degrees of freedom; MS: mean squares.
** = $p < 0.01$; * = $p < 0.05$

Senior professors had significantly lower levels of coauthorship dissatisfaction than associate professors, assistant professors, and adjuncts, although there was no difference with professors (table 7). The same occurred with professors: their score was significantly higher than in all the professional categories below them except for the one directly below them (associate professor), with whom there was no difference. The statistical differences detected between the different positions on the hierarchical scale, then, confirm H_2.

Table 7. Tukey's test according to professional category

	Senior professor	**Professor**	**Associate professor**	**Assistant professor**	**Adjunct**
Senior professor	1.000				
Professor	0.065 ns	1.000			
Associate professor	0.013 *	0.729 ns	1.000		
Assistant professor	0.000 **	0.040 *	0.575 ns	1.000	
Adjunct	0.000 **	0.023 *	0.692 ns	0.995 ns	1.000

** = $p < 0.01$; * = $p < 0.05$; ns = non-significant

After examining the influence of the area of knowledge and professional category on levels of coauthorship dissatisfaction, we considered a third hypothesis: that women would register higher levels of dissatisfaction than men (H_3). As the differences between

professional categories had already been established, we controlled for this variable in our analysis based on gender, that is, stratifying results within each professional category using the student's *t* test for independent samples.

The results obtained are shown in table 8. Coauthorship dissatisfaction only significantly differs by gender among professors; female professors report higher levels of dissatisfaction than their male counterparts. In the other professional categories, the differences are not statistically significant.

Table 8. Student's *t* test for independent samples, by sex

Professional categories	**Sex**		**Student's *t* test**		
	Men	**Women**	***t***	**df**	***p* value (2-tailed)**
Senior professor ǂ	0.06	0.14	−1.661	116.933	0.099 ns
Professor ǂ	0.13	0.22	−2.096	486.238	0.037 *
Associate professor	0.19	0.25	−0.798	253.000	0.426 ns
Assistant professor	0.34	0.24	0.918	178.000	0.360 ns
Adjunct	0.24	0.33	−1.138	248.707	0.256 ns

ǂ= equal variances not assumed (Levene's test); ** = $p < 0.01$; * = $p < 0.05$; ns = non-significant

These results do not confirm H_3 in the sense that they do not show significantly different levels of dissatisfaction between men and women within each professional category. However, the results could be conditioned by the existing subsample in each category and by the fact that cases were grouped regardless of area of knowledge. These decisions could have attenuated the differences.

To analyze this hypothesis more robustly from a multivariable perspective, we performed a linear regression analysis. Coauthorship dissatisfaction was the dependent variable, while independent variables were area of knowledge, gender and professional category, although these had previously been transformed into dummy variables. The reference categories were the area of Arts and Humanities, the professional category of "other figures," and men.

The results obtained (table 9) show that working in the discipline of Health Sciences and being a woman were the two variables associated with the highest risk of coauthorship dissatisfaction, yielding a *p* value of less than 0.01 in both cases. Moreover, these variables also showed the highest standardized beta coefficients (0.085 and 0.073, respectively.

Belonging to the Social Sciences field and being an assistant professor or adjunct were associated with the next highest risk, although in these cases the statistical significance was slightly weaker ($p < 0.05$). By contrast, the only standardized beta coefficient with a

negative value and significant *p* value corresponded to the figure of senior professor, indicating that this is the only condition that was predictive of lower levels of dissatisfaction related to coauthorships.

Table 9. Linear regression analysis of dissatisfaction index

Independent variables		**ß**	***t***	***p* value**
(Constant)		—	2.014	0.044 *
Sex (ref. men)	Women	0.066	3.149	0.002 **
Area of knowledge (ref. Arts and Humanities)	Exact Sciences	0.038	1.318	0.188 ns
	Health Sciences	0.085	2.976	0.003 **
	Social Sciences	0.073	2.510	0.012 *
	Engineering	0.054	1.907	0.057 ns
Professional category (ref. Other professional figures)	Senior professor	−0.060	−2.340	0.019 *
	Professor	−0.010	−0.344	0.731 ns
	Associate professor	0.016	0.643	0.520 ns
	Assistant professor	0.048	2.053	0.040 *
	Adjunct	0.050	2.004	0.045 *

** = $p < 0.01$; * = $p < 0.05$; ns = non-significant. Adjusted R Square = 18%

The results presented here, therefore, confirm the three hypotheses related to coauthorship problems that we set out to test. Dissatisfaction is considerably higher in Health and Social Sciences, in lower professional categories, and among women.

5. DISCUSSION

From a theoretical point of view, the problems and conflicts in coauthorship of scientific publications stem from the existence of a social-academic order and more specifically to the conflicts and benefits related to symbolic capital. Quantifying these problems and conflicts is methodologically complex for several reasons. The decision about who should assume the role of author and take the responsibility for the published content has subjective components, and these cannot be reduced to identifying who performed a minimum or specific number of tasks. The research community assigns great value to aspects like effort and time, the relevance and importance of different contributions, the generation of financial resources, and the relationship of academic leadership or mentoring, and these considerations are used to justify authorship (Bhopal et al. 1997; Lariviere et al. 2016; Youtie and Bozeman 2016). Furthermore, every discipline has its own traditions, and researchers' perceptions on authorship may vary according to their expectations of recognition. Although the guidelines published by different associations and journal editors have tried to resolve this question, difficulties in determining who

should be considered an author persist (Croll 1984; Laudel, 2002). This is evidenced by the modifications to the criteria for authorship in successive versions of the ICMJE guidelines (ICMJE 2008; ICMJE 2013), the studies showing widespread non-compliance to guidelines among journal authors, and the variations between different guidelines used. In this sense, Tarnow (2002) found that in the field of physics, the probability that a given coauthorship was considered inappropriate ranged from 23% to 67%, depending on whether the reference guideline was the American Physical Society or the ICMJE.

The absence of an objective framework for authorship, combined with the use of different methodological approaches to assess problems and mala praxis associated with signing scientific publications, explains the heterogeneous results of the different studies that have quantified this aspect. The studies can be divided into those looking to quantify researchers' perceptions on coauthorship problems and those aiming to measure the degree of compliance with authorship criteria from formal guidelines. With this division in mind, the range of results on the quantity of honorary authorships are relatively narrow in range: according to the first approach, 10% to 38% of authorships are honorary (Martinson et al. 2005; Bhopal et al. 1997); using the second approach, the figures lie between 39% and 60% (Mowatt et al. 2002; Marusic et al. 2004). The studies that have incorporated estimations of both aspects show significant differences between the measures of honorary authorship. Eisenberg et al. (2011) found a rate of 26.0% using the first metric and 58.9% using the second. These are very similar to the results reported by Bonekamp et al. (2012), of 24.7% and 57.6%, respectively. Rajasearan et al.'s (2014) findings were slightly lower, at 18.0% and 55.2%, respectively, while Shah et al. (2018) found rates of 20.9% and 60%, respectively.

In any case, the biggest difference between these two measures reflects a separation between the daily practice of scientists and journal editors. This finding is consistent with Street et al.'s (2010) conclusions that the strict norms of scientific editors are often misaligned with the practical and implicit norms that regulate the everyday work of academics.

In addition to heterogeneity in study periods and samples, the differences in the results reported in the literature can be attributed to researchers' narrow focus on a very specific field or subfield (Burman 1982; Slone 1996; Hoen et al. 1998; Marusic et al. 2004; Ivanis et al. 2008; Eisenberg et al. 2011; Bonekamp et al. 2012; Eisenberg et al. 2014; Rajasekaran et al. 2014). To date, no studies have examined all disciplines. Most have looked only at the Health Sciences. According to our results, this is the branch of knowledge that is most affected by authorship problems and would thus logically center the most concern about these issues. Moreover, this would also explain why our aggregated results across all areas are lower than the figures reported to date in the literature. Indeed, the result we obtained for the area of Health Sciences is within the

range of previously reported results, as dissatisfaction in this area is higher than in other scientific areas or branches.

Another aspect that may contribute to the heterogeneous results is sample size. Generally, studies with the smallest samples—around 50 authors (Bhopal at al. 1997; Pignatelli et al. 2005)—have reported the highest rates of inappropriate authorship, while large studies like the one reported by Martinson et al. (2005) show lower rates, as does ours.

The number of authors signing different publications may also have an effect, as can the author to whom the survey is directed, which is usually the first author on the byline or the corresponding author. For example, Slone (1996) found that the incidence of undeserved authorship rose from 9% in articles with three authors to 30% in papers with more than six. Marusic et al. (2004) found that the percentage of authors meeting ICMJE criteria decreased as the number of authors increased, albeit there were differences according to whether it was the first author or other authors who responded to the question.

In the present study, 8.7% of respondents reported that coauthored publications did not adequately reflect collaborative work. This result is slightly lower than previous estimates on researcher perceptions of authorship problems, which range from 10% to 38%. This difference could be due to the methods used, as we considered all disciplines and authors, independently of the position they had on author lists or the number of coauthors on the documents they signed. Moreover, unlike most other studies, we did not focus on a small number of leading or high-impact journals, and we used a very large sample size (N=2344). In addition, the fact that we surveyed people instead of documents, assessing a much broader concept than merely authorship or signatures (analysis of satisfaction with collaborative publications) could explain why our results were not more dramatic. That said, our findings of the differences in dissatisfaction related to branches of knowledge, professional status, and gender are quite relevant.

5.1. Branches of knowledge

There have been few comparative analyses between branches of knowledge with regard to authorship problems on scientific publications, and those that have been undertaken have generally been based on observations and subjective impressions (Biagioli 2003; Pontille 2004; Birnholtz 2006) or limited to the analysis of tasks performed in collaboration and considering variables like the order of author signatures (Shapiro et al. 1994). In this sense, Lariviere et al. (2016) described different patterns in the division of work between disciplines, which were reflected in the attribution of authorship.

We observed differences in coauthorship dissatisfaction between branches of knowledge, with the highest prevalence of problems in the Health Sciences, followed by Social Sciences. The longer and more deeply rooted tradition of collaborative working and publication in the Exact Sciences, or the greater predominance of individual work and publication in the Arts and Humanities, could help explain the smaller number of conflicts in these areas of knowledge compared to other branches that have seen more recent growth in the mean number of authors (Glänzel 2002; Henriksen 2016).

5.2. Hierarchy

With regard to the relationship between authorship problems and position on the academic hierarchy, our results corroborate previous studies showing that authors with lesser academic and professional status perceive more problems. As in other social spheres, in Science too, there are different power dynamics at play in relation to systems for reputational benefits and rewards derived from participation in scientific publications (Zuckerman 1970; Bourdieu 1975; Whitley 1985). Heffner (1979) was among the earliest to point out that credit associated with scientific publications was not always associated with universal principles, describing subauthorship and the exclusion of certain junior academics from the author list of scientific publications. And Wilcox (1998) analyzed the evolution of the number of disputes about problems of coauthorship, concluding that these problems were growing and that they affected non-faculty members more than faculty. Eisenberg et al. (2011) studied these questions with more specificity, using a questionnaire administered to the first authors of *Radiology and European Radiology* and finding that respondents of lower academic rank were more likely to report the existence of honorary authorships. In the same line, Rajasekaran et al. (2014) also used a questionnaire to survey the first authors of physical medicine and rehabilitation journals, reporting that being a fellow or medical resident was significantly associated with perceiving honorary authorships. In addition to reflecting a position of power, this degree of honorary authorships among consolidated scientists with higher hierarchical rank may also indicate the systematic entrenchment of this behavior. Junior researchers—and especially those just getting started—also admit to inappropriately assigning authorship credit (Martinson et al. 2005), possibly to gain recognition and visibility in the early stages of their career, or simply as a reproduction of the behaviors observed in senior academics.

Regarding the order of author signatures, this not only reflects the distribution of scientific tasks and the relevance of the contributions, but also the inequalities that exist or are reproduced in scientific fields. Our findings are consistent with the conclusions reported elsewhere: that academic status and rank influence the position of names on the author list, and this is related to strategies of career advancement and efforts to gain prestige or recognition (Burman 1982; Hart, 2000; Bozeman and Youtie 2016). Along this line of inquiry, Drenth (1998) analyzed documents published in the *British Medical*

Journal over 20 years (1975-1995), reporting that senior researchers had increased their degree of participation as first authors at the expense of other author positions.

5.3. Gender

Numerous studies have analyzed the gender-related differences and discrimination in relation to publications and coauthorships (Wilcox 1998), including with regard to scientific productivity (Moya-Anegón et al. 2004), citations (Lariviere at al. 2013), discrimination related to academic promotions when women do not publish alone (Sarsons 2017), subauthorships (Heffner 1979), and author signature. This body of work has revealed the inequalities and mechanisms of discrimination both within and outside of an academic field. Wilkie and Allen (1975) showed that in the field of Sociology, the most relevant positions on different publications were dominated by men. Other studies have also identified lower citation rates for women's research, their lower presence in the first and last positions of author lists (West at al. 2013; Lariviere et al. 2013; Ghiasi et al. 2018), and a greater number of authors on papers where women occupy the first and last positions on the byline (Ghiasi et al. 2018).

The scarcity of studies specifically looking at the problems of ghost and honorary authorships in relation to gender is noteworthy. Our results confirm that women are more likely to perceive these problems than men, in a further reflection of the social inequalities and mechanisms of social discrimination in the scientific field.

6. CONCLUSIONS

The increase in collaborative practices in knowledge generation is one of the characteristic features of science. This increase—while on the whole positive—entails certain complexities when attributing credit based primarily on authorship. There is a fundamental disconcordance between a system of knowledge production that is based on collaboration between scientists and even groups of scientists, on the one hand, and a system for assigning merit and distributing rewards that functions on an individual scale, on the other, with authorship of scientific publications straddling these two spheres.

These circumstances give rise to bad behaviors related to joint publications, generally related to three issues: inappropriate author order on the byline, the exclusion on the author list of researchers who have participated in a relevant and substantive way to the research, and the inclusion of people on the author list who have not participated in the research enough to justify their recognition. Attempts to quantify these problems have resulted in important disparities between studies and methods, adding to the difficuly of identifying trends related to the phenomena.

The present study was based on a large sample of researchers (N = 2344 from a total population of 12,406), which reduces the risk of bias in previous studies. An important strength, moreover, is its examination of all scientific branches, which enables comparisons and the identification of differences between them. Our estimation of the scope of the problem is sensibly lower than in most other studies that have examined coauthorship problems. In addition, we were able to link some problems of collaborative publication with social differences, in terms of both academic rank and gender. The researchers who were most likely to perceive problems in coauthorship were those in lower academic positions, women, and researchers working in Health and Social Sciences. Future studies should build on the present work by attempting to establish trends and by complementing our survey-based findings through the analysis of documents.

The differences we identified can surely be helped through the existence of guidelines on authorship attribution. However, the rules in place do not seem sufficient. The informal practices and implicit rules that govern academia are difficult to capture through regulations. Moreover, these vary according to areas and disciplines and have to apply to an increasingly dynamic context, in which multidisciplinary and interdisciplinary research is increasingly relevant.

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