OPINION

Authors overestimate their contribution to scientific work, demonstrating a strong bias

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Teamwork is an essential component of science. It affords the exchange of ideas and the execution of research that can entail high levels of complexity and scope. Collaborative science also leads to higher-impact publications relative to single-authored research projects (1). Published articles are a key product of scientific work, bearing considerable impact on researchers' academic stances and scientific reputations (2). As such, determination of the relative contribution of each coauthor to the collaborative work is of much significance, and is often reflected in the order of the authorship byline or in comments describing the differential contribution of each of the coauthors to the article (3).

Although the scientific community is aware of the challenges associated with accrediting relative contribution in multiauthored papers (4) and scientific journals have developed guidelines to promote more responsible authorship allocation (5–7), almost any researcher who has published a coauthored article is well-aware of the emotional and political undercurrents associated with sorting out the relative contribution to a publication. While previous work has concentrated on elucidating the problems associated with credit

Authors often have an outsized estimate of their contributions to a given paper. Image credit: Dave Cutler (artist).

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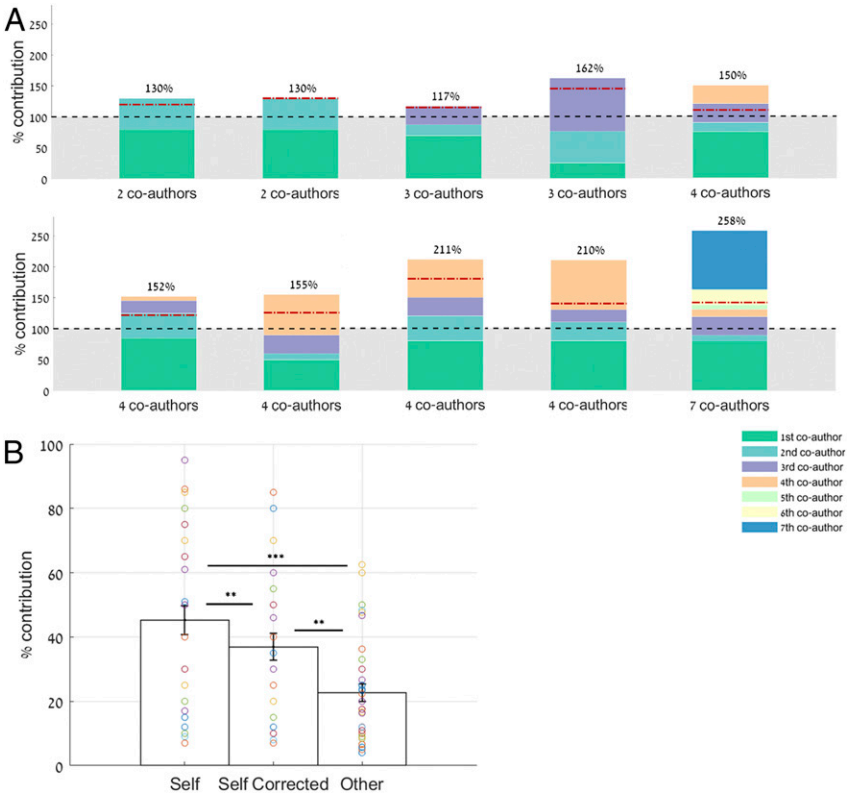

Fig. 1. We found biased estimations of personal contributions to scientific articles. The sum of coauthors percent contribution to 10 published manuscripts is shown in (*A*). The red dash-dotted line represents the sum of coauthors' contributions after they were given the opportunity to adjust their own percent contribution. In (*B*) we show the mean percent contribution assigned by coauthors to themselves in Step 1 ("Self"), percent contribution coauthors assigned to themselves after given the opportunity to adjust their contribution not to exceed 100% in Step 2 ("Self-Corrected"), and mean percent contribution assigned to authors by their coauthors ("Other"). Error bars represent standard errors of the means. **p<.01, ***p<.0001.

allocation (8–10) and on developing quantitative tools to determine degree of contribution (4, 11), scholars have not studied authors' subjective evaluations of their own and their coauthors' contributions to coauthored publications. Biased perception of the magnitude of one's own relative to others' contribution to scientific work can set the stage for dissatisfaction, disputes, and setbacks to collaborative work.

Our research has found that, regardless of an author's placement in the order of article authorship, most authors possess deep-rooted biases regarding how much they've actually contributed to a collaborative work. Psychological research has delineated the existence of self-serving biases in teamwork (12, 13). Here, we demonstrate that such bias also exists in the context of perceived personal contribution to published scientific teamwork and show that these biases run deep and wide—perhaps not surprisingly, given their robust emotional and practical implications (14). The results suggest that the science community, including journals and higher education, should raise awareness and take action to lessen this bias across the research enterprise.

Calculating Bias

To explore the potential extent of author bias, we contacted all coauthors of predefined published papers and measured their perceived contribution to their respective projects. For purpose of illustration, we selected 10 manuscripts published in the past two years, listing two to seven different coauthors each (total number of coauthors = 37). Coauthors were 51% female, from 13 different universities located in four different countries, and ranged in academic ranking from master's of arts students to emeritus professors. The selected articles were from the top quartile in their subfields according to Web of Science. We selected articles led by principal investigators who agreed to assist with data collection and applied an online platform (Qualtrics, version July 2018–January 2019, Provo, UT) to survey subjective estimation of contribution to the predefined articles. The purpose of our survey was not discussed with the coauthors and they were told that we were generally interested in how researchers estimate their contributions to published articles.

First, we asked each coauthor to generally estimate—with a percentage—his or her own contribution to the identified article (Step 1). Then, in Step 2, we "gently reminded" each coauthor that the sum total of percent contribution across all coauthors must add up to 100% and asked them to determine again their own contribution. This time, however, they were also

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to estimate the relative contribution of each of their coauthors listed in the article.

Three bias indices were calculated: 1) Article-related self-contribution bias reflecting the sum of the percent contributions provided by each of the coauthors in response to the initial question (Step 1). Given that the sum of contributions across coauthors amounts only to 100%, any score exceeding 100% reflects a self-serving bias, at least for one of the coauthors. 2) Self-corrected contribution bias. If coauthors overestimated their contribution in Step 1, we were interested in whether they were able to mitigate their initial bias following our "kind reminder" in step 2. Here too, we summed the self-assigned contribution in percent across coauthors. Finally, 3) we calculated the difference between the self-assigned contribution of each coauthor and the mean contribution assigned to him or her by the rest of the coauthors. Here, we demonstrate the existence of these three biases in 10 out of 10 preselected articles.

Fig. 1 portrays the above-described biases. In all of the surveyed articles, the sum of individual contributions (Step 1) exceeds 100% ($M = 167.5\%$), $t(9) = 4.77$, $p = .001$, $d = 1.5$. While coauthors were able to somewhat mitigate their self-serving bias when reminded that the sum of contribution across coauthors must add up to 100%, $t(35) = 3.52$, $p = .001$, $d = .58$, the sum of corrected contribution across coauthors remained consistently above 100% in all articles ($M = 133\%$), $t(9) = 5.15$, $p = .001$, $d = 1.60$. The percent contribution each coauthor assigned to himself or herself was higher than the mean contribution score assigned to them by the rest of the coauthors ($M_{difference} = 22.6\%$), $t(72) = 4.48$, $p = .00002$, $d = 1.04$. This bias remained even after coauthors were given a chance to adjust their self-contribution in Step 2 ($M_{difference} = 13.8\%$), $t(72) = 2.89$, $p = .005$, $d = .67$. All the above described biases emerged consistently, regardless of gender, location in the authorship byline, academic experience (number of articles published), or academic title.

Deeply rooted biases in perceived self-contribution to scientific publication may have deleterious implications for collaborative science.

Mitigating Bias

Our demonstration highlights two conclusions, one pessimistic and the other somewhat optimistic. On the pessimistic side, it's clear that most researchers have a robust self-serving bias in estimating their own contribution to coauthored scientific publications. Simply put, researchers estimate their own contributions as greater than they probably are and greater than what their coauthors think they are. Furthermore, this self-serving bias cannot be extinguished even when it is made explicit and obvious. This suggests that the process of assigning credit in coauthored articles must entail considerable amounts of dissatisfaction and feelings of distorted or even unfair recognition of relative contribution.

Importantly, while we did not directly investigate the order of authorship byline, we assume that the bias we describe can influence decisions about author order. It is also worth noting that our demonstration relates to already published work. It is conceivable that biased estimations are even stronger before a manuscript has been published, e.g., before the order of authorship byline has been determined and cemented.

On the optimistic side, our demonstration also suggests that researchers can significantly reduce their self-serving bias if made aware of it. Even a "gentle reminder" that the amount of contribution across coauthors should sum to 100% was effective in reducing the self-serving bias by 34%.

So, what can be done to mitigate detrimental egocentric biases in collaborative science? One important approach is to increase awareness among researchers at all levels regarding the scope of self-serving contribution biases, as well as overestimations of self-contribution to published teamwork. Leading journals could help by enhancing visibility of the issue by publishing articles about this topic or dedicating special sections to discuss different aspects of this phenomenon and its implications. Incorporating relevant discussion into undergraduate and graduate curricula would also help, as would encouraging open discussion of this bias in scientific forums and within research groups.

Part of the described bias may result from the fact that authors have better knowledge about their own efforts in promoting the research project relative to the efforts of other coauthors (15). If so, increasing the availability of information about each coauthor's contribution could further decrease self-serving biases in contribution to published teamwork. This could be implemented unofficially or through more systematic evaluations. For example, studies have applied formal peer and self-evaluation instruments to increase transparency of perceived contribution by requesting all team members to evaluate their own and their team members' contributions to a project as it unfolds. Based on these data, feedback is provided to each member about the team evaluation of his or her contribution (16).

While using such instruments can increase transparency and enable flagging of "exceptional conditions" that warrant attention—such as marked discrepancy between coauthors' responses—it may also prove tedious and detrimental to team morale. Importantly, future studies could empirically test the relative efficacy of different approaches to mitigating these biases and investigate the conditions magnifying it. For example, conditions promoting competition, such as environments with an elevated pressure to publish or in publications in journals with a higher impact factor, might magnify the demonstrated self-serving bias.

Another approach to credit allocation issues in scientific publication is to abandon the current byline credit system in favor of a "contributorship" model (17). Under this model, all individuals who have contributed to a project are credited based on the tasks in which they were involved. This approach can avoid the thorny

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process of estimating magnitude of contribution and overcome the rising number of equal contribution statements (18–20) that lack clear guidelines and raise concerns about dishonest credit allocation for career advancement (21).

Declaring authors' specific contributions can be valuable for interested parties, such as hiring institutions or grant providers, and can guide readers to authors holding desired skills for the purposes of research collaboration, scientific advice, or manuscript review (17).

A coding system (CRediT, the Contributor Roles Taxonomy) has been adopted by several scholarly publishers (17). However, the traction of this alternative credit system seems rather low, with very few journals (5.33%) implementing it (5). Although discussion of the effectiveness of a contributorship system is beyond the scope of the current manuscript, it may be valuable to point out that the self-serving contribution biases demonstrated here could quite easily infiltrate the so-called objective contribution categories offered by such systems. For example, contribution to the methodology of the study, one of the CRediT categories, can be claimed by a coauthor that provided task stimuli that are perceived by him or her to significantly promote the research methodology, while perceived as a negligible contribution by the other coauthors.

Regardless of the measures considered, it's important we, as a science community, highlight the problem. Deeply rooted biases in perceived self-contribution to scientific publication may have deleterious implications for collaborative science. As a result, we call on the scientific community to increase awareness about this phenomenon and device practical ways to reduce it.

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