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Aberration of the Citation

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ABSTRACT

Multiple inherent biases related to different citation practices (for e.g., self-citations, negative citations, wrong citations, multi-authorship-biased citations, honorary citations, circumstantial citations, discriminatory citations, selective and arbitrary citations, etc.) make citation-based bibliometrics strongly flawed and defective measures. A paper can be highly cited for a while (for e.g., under circumstantial or transitional knowledge), but years later it may appear that its findings, paradigms, or theories were untrue or invalid anymore. By contrast, a paper may remain shelved or overlooked for years or decades, but new studies or discoveries may actualize its subject at any moment. As citation-based metrics are transformed into "commercial activities," the "citation credit" should be considered on a commercial basis too, in the sense that "citation credit" should be shared out as a "citation dividend" by shareholders (coauthors) averagely or proportionally to their contributions but not fully appropriated by each of them. At equal numbers of citations, the greater number of authors, the lower "citation credit" should be and vice versa. Overlooking the presence of distorted and subjective citation practices makes many people and administrators "obsessed" with the number of citations to such an extent to run after "highly cited" authors and to create specialized citation databases for commercial purposes. Citation-based bibliometrics, however, are unreliable and unscientific measures; citation counts do not mean that a more cited work is of a higher quality or accuracy than a less cited work because citations do not measure the quality or accuracy. Citations do not mean that a highly cited author or journal is more commendable than a less cited author or journal. Citations are not more than countable numbers: no more, no less.

KEYWORDS

Citation; citation index; citation analysis; citation bias; honorary authorship; impact factor; journal impact factor; publication bias

Introduction

The game of numbers seems to be irresistible for many researchers and administrators in spite of the subjectivity and biases in the dissemination of research findings (Song et al., 2010). Striving to compete is sometimes accompanied with many biases introduced into the body of scientific knowledge alongside its production's path from the attribution of funds to the final

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phase of publication and citation. Citation biases are one of many other problems in a broader context of unethical practices affecting science and scientific publications, such as authorship issues (Seeman and House, 2015; 2010; Bennett and Taylor, 2003), redundant or duplicate publications (Abraham, 2000; Hennessey et al., 2012; de Vasconcelos and Roig, 2015), hyper-authorship (Cronin, 2001), bias in editorial decisions (Kotchoubey, Butof, and Sitaram, 2015; Moustafa, 2015b), and in ethical decision making among university faculty (Medeiros et al., 2014), plagiarism (Resnik, 2013; Bird, 2002), guest and ghost authorship (Wislar et al., 2011; Ngai et al., 2005), research misconducts (Resnik, Rasmussen, and Kissling, 2015; Spier and Bird, 2000), and many other contradictions and pitfalls (Moustafa, 2014).

Rough competitions have transformed citation-based bibliometrics into industrial activities that, in turn, transformed the scientific publications into "commercial products" and citations into direct or indirect monetized rewards (grants, funds, promotions, etc.). Beyond these rewardable and commercial dimensions of this process, and notwithstanding the value of citations in the diffusion of honest and reliable scientific knowledge, citation-based metrics are unquestionably defective with multiple shortcomings and caveats (Leydesdorff, 2008; MacRoberts and MacRoberts, 1996) related to different subjective and biased citation practices, some of them are discussed below.

Self-citations

Self-citation is the citation of his own publications for different purposes, for example, to promote his own work, to create an image of scientific authority, to refer to previously addressed information or findings, or simply for self-aggrandizement (Foley and Della Sala, 2010). Self-citation by default is not necessarily bad or negative (Ioannidis, 2015)—rather it is sometimes necessary, but it is the biased and exaggerative values built on citations that make citations-based metrics as flawed and unreliable measures. Indeed, by manipulating self-citations, authors can easily inflate their *h-index* (Bartneck and Kokkelmans, 2011) and distort the scientific knowledge towards more conformism (Ioannidis, 2015). Some studies report that self-citations account for approximately 10–20% of all citations, depending on fields and their development levels (Hyland, 2003). For example, in high-profile general medicine journals, about 6.6% (Kulkarni et al., 2011) and in diabetes literature about one-fifth of all citations (Gami et al., 2004) were self-citations, suggesting that self-citations substantially affect the overall citation-based metrics.

Negative citations

An article can be highly cited because authors try to refute its claims or to cite it as an example of controversy or disagreement. A paper in which there has been reason to question an experimental method may be highly cited as an example of how not to behave (Spier, 2009). A negative citation can be used to point out weakness, inconsistencies, or defects in a methodology. In a recent study, it was found that negative citations represented about 2.4% of the total citation in immunology (Catalini, Lacetera, and Oettl, 2015). On the other hand, a citation that favors statistically significant or "positive" results may mislead readers of medical literature on medical treatments that may appear more efficient than they really are (Jannot et al., 2013).

Wrong or error citations

It is not uncommon that many errors in citation can be introduced in the authors' or journals' names (i.e., one journal can be replaced by another) or errors in the date or the backed-up information itself (intentional or unintentional misinterpretation). An example of historical citation errors of this kind comes from an article by supposedly a Czech doctor, called O. Uplavici, which has been cited for more than 55 years before it appears that O. Uplavici was the title of the article but not the author's name (Vickers, 1995). Some citation errors may also be innocent misunderstanding of the original source but sometimes they are intentional, particularly in self-citation when an author cites his or her own previous work (Vickers, 1995). Many risk factors for citation errors have been reported in journals in different fields such as in nursing (Lok, Chan, and Martinson, 2001) and otolaryngology surgery (Fenton et al., 2000), which could be applied on journals in other fields, too. Reference errors often result in inaccuracies in citation indexes, difficulty in reference retrieval, and failure to credit the right authors (Taylor, 2002).

Honorary citations

Some authors may tend to cite papers from their colleagues, their old or future supervisors or trainees, or from specific teams, or people they know much more than from other sources. People who are well known in leading laboratories cite their own (Spier, 2009). Honorary citations are tightly related to honorary authorship that may reach up 25% of research reports and 15% of review articles, emphasizing the need to address this problem efficiently and to end up with it (Greenland and Fontanarosa, 2012).

Discriminatory citations

Some authors tend to superciliously cite papers only from specific journals, resulting in a substantial increase in their impact factors. Authors who cite only journals with "high impact factors" contribute in maintaining the high impact factor of those journals based on an "accumulated advantages" effect where the "rich get richer and the poor get poorer." Other authors may also contempt to cite the work of junior or unknown authors by "proudness," "arrogance," or sexism. Articles written by women, for example, appear to receive fewer citations than articles written by men, when a woman is a sole author, first author, or last author (Lariviere et al., 2013). In the same way that English journals are more advantageous for the impact factor (based on citations) than non-English journals (González-Alcaide, Valderrama-Zurián, and Aleixandre-Benavent, 2012), potential discriminatory citation behaviors between native- and non-native English authors may also exist and need to be explored empirically and thoroughly. Such analyses should help point out other biases and latent aberrations of the citation related, for example, to names, ethnicity, countries, native English authors versus non-native English authors, etc.

Popular and specialized citations

Papers reporting on research in areas where many research grants, institutions, researchers, support, and journals exist are more liable to be highly cited than papers dealing with new subject areas or highly specialized topics (Spier, 2009). Similarly, papers in popular area, such as curing diseases (therapy), where a lot of people are working, are more citable than papers dealing with prevention (vaccination). It is thus a subjective and unethical praise to compare popular and well-established research areas with new or narrowly specialized research.

Reciprocal citations

Some authors may tend to cite publications of people who cite their own work more than those who do not (cite me, and I cite you!). In an analysis of about 50,000 papers published in the journal *Science*, it was reported that authors who cite the work of other authors are more likely to find their own work cited, in turn (Corbyn, 2010).

Circumstantial citations

The scientific "truth" is uncertain (Spier and Poland, 2013). Knowledge is prone to change over time when the context or circumstances change, for example, as a result of substantial technological advancements or the application of new methodology or tools (*transitional* or *circumstantial knowledge*). As a result, a new type of citation that we can call "*transitional* or *circumstantial citation*" will appear, and could be defined as the "*citation built on circumstantial knowledge available under given circumstances, skills* *or period*." A paper can thus be highly cited for a while under *circumstantial knowledge*, but some years later it may prove that its findings or theories for which it has been heavily cited were untrue or invalid anymore. As an example of this kind of knowledge, the number of human genes for instance started as high as 120,000 genes (Liang et al., 2000), but it has continued to diminish as low as 19,000 genes (Ezkurdia et al., 2014) with high citation rates of the "wrong" gene numbers. The gene counter is still ON, and the "final" number of human genes may decrease (or increase) in the future as a result of new fine-tuning or new technological advancements.

Table 1 shows papers reporting different sets of human genes' numbers. Two of them are particularly highly cited: the first by Venter et al.(2001) reporting the number of human genes at 38,588 genes with a total citation of 12,901 times. The second by Lander et al.(2001), who predicted the gene number at 30,000–40,000 genes with a total citation of 17,986 times. Other reports predict human genes at 20,500 genes (Clamp et al., 2007) or even less. The predicted gene number, however, in the two aforementioned highly cited papers seem to be "wrong" or far from the most recent estimation at about 19,000 genes (Ezkurdia et al., 2014). As it can be seen in Table 1, the number of citations is particularly high for papers reporting "wrong" information or data that appear to be "imprecise" over time, suggesting that high citation counts do not necessarily reflect accuracy.

Table 1. The challenge of the human genes' number as an example of the uncertainty of the scientific knowledge (*transitional or circumstantial knowledge*) that demonstrate that citation-based bibliometrics are not necessarily meaningful or reliable.

Number of predicted human genes	Reference	Number of citations*
50,000–100,000	Schuler et al. (1996)	1,157
30,000	Deloukas et al. (1998)	705
120,000	Liang et al. (2000)	281
80,000–100,000	Quackenbush et al. (2000)	465
38,588	Venter et al. (2001)	12,901
30,000–40,000	Lander et al. (2001)	17,986
23,000–24,500	Pennisi (2003)	79
20,000–25,000	International Human Genome Sequencing (2004)	2,711
20,500	Clamp et al. (2007)	412
20,687	Encode Project Consortium (2012)	2,966
19,000	Ezkurdia et al. (2014)	36

* The numbers of citations were retrieved from Google Scholar by using the publications' titles as research queries.

The number of human genes began as high as 120,000 genes (Liang et al., 2000), but it has continued to shrink to as low as 19,000 genes (Ezkurdia et al., 2014), spanning other predictions and counts that have appeared 'untrue' or unconfirmed.

Two highly cited papers (Venter et al., 2001; Lander et al., 2001) report the gene numbers at about 30,000–40,000 genes with total citations of 12,901 and 17,986 times, respectively. However, these numbers seem to be "wrong" compared to the most recent gene count of about ~19,000–20,000, supposedly to be the most "accurate." This suggests that high citation rates and "accuracy" do not necessarily match. High citation counts can be generated under transitional or circumstantial knowledge that is subject to change, making citation-based bibliometrics unreliable.

This discrepancy raises another problem of citation that can be called "*sectional citation*" or "*segmental citation*" (or *random citation*) related to which "segment of information" or claim in a paper is cited. For example, are the two above-mentioned highly cited papers (by Venter and Lander) were cited for the number of genes or for other information? Depending on the purposes of authors and their personal appreciations or judgments of a paper, some authors may cite more or less essential information; others may cite accessory information or a tiny detail in a paper, etc. For authors, it would not matter much which information piece in their papers is cited—the citation credit will be won anyway—but for an objective assessment of the scientific quality, supposedly to be reflected in citation-based metrics, but it is not the case currently, suggesting the presence of additional flaws in the citation-based metrics because citation-based metrics do not consider such subtleties.

Another example of circumstantial knowledge is the "Junk DNA" conception that is likely to disappear (Pennisi, 2012), arguably with the citation values that have been generated with. As such, under transitional phases of knowledge that may be invalidated one day, citation-based metrics may overevaluate a paper's metrics when it is heavily cited, but its findings may be wrong or subject to change over time. In other words, citation-based metrics do not distinguish between accuracy (real impact) and citations (abstract numbers).

Fluctuating journal impact factors is a further example of the aberrations of citation-based bibliometrics. Under same editorial policy and staff, a journal may be highly cited during a given range of time, and subsequently, its impact factor will inflate considerably, but in other periods its impact factor may decrease noticeably. Does this mean that the quality of that journal has been decreased? Not necessarily because nothing would have been changed with the journal policy and staff (the journal remained the same journal with its staff!), but rather it is the consequence of inherent biases related to citation-based metrics and behaviors, discussed here.

Multi-authorship citations

The current citation-based bibliometrics allocate the same "citation credit" to all coauthors (one citation, one credit) whatever their number or their contributions (Figure 1). Such a system is undeniably biased because it treats all coauthors as if they were single authors. On the other hand, single authors spend alone all the required efforts for their manuscripts from conception to communication of the results compared to multiple coauthors who theoretically should share task chunks, but practically the contribution of some coauthors, particularly in long authorship lists, which may reach up 200 coauthors or more in some cases (Moustafa, 2014), may not exceed a simple skim or quick reading at most. Worse, sometimes there are many authors for a piece of hardly 200–300 words with some authors proudly affiliating

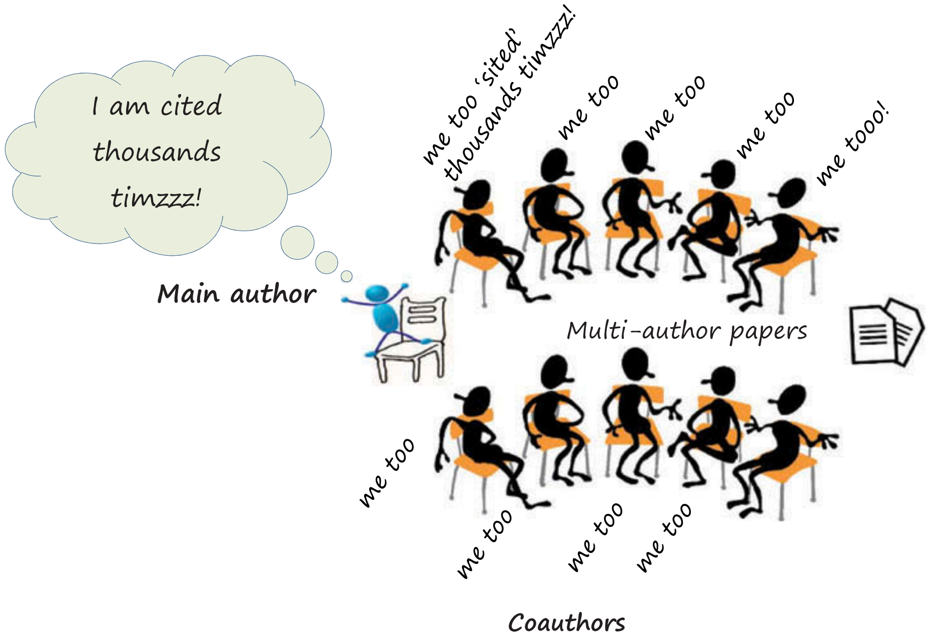

Figure 1. Multi-author papers undeniably inflate the 'citation credit' of each coauthor who may contribute little or nothing at all. Averaging citation credit would be a potential solution to reduce such biases in the publication world.

themselves to many institutions at the same time, making the list of institutions as long as, if not longer than, the text itself. In other words, efforts shared out by many contributors cannot justify an objective full "citation credit" for each coauthor. Allocating the same full "citation credit" to all coauthors is an obvious contradiction with the authorship principles and with the efforts of each coauthor expends, particularly in honorary authorship lists where some authors are listed merely for honorific purposes without real contributions (for, e.g., to give credit to an article by including famous names to get approved publication or grant).

Long lists of coauthors seriously devaluate the authorship process (van Wesel, 2015) and papers with multiple authors are often associated with multiple problems for journals, for citation-based metrics, and for authors themselves (Bozeman and Youtie, 2015)(Kennedy, 2003). For journals, long lists of coauthors are hard to deal with, particularly when something goes wrong with the publication (e.g., research misconduct) (Kennedy, 2003). For citation-based metrics, when an article has many coauthors, the number of possible self-citation increases, amplifying the would-be "scientific impact" or findings (Foley and Della Sala, 2010). Multiple authorship can thus bias the self-citations practice which, in turn, biases the overall citation rates, creating a false impression of "high impact." In cardiovascular medicine or infectious disease publications, it was found that multi-author papers are associated with more self-citation (Kulkarni et al., 2011). Multi-authors' self-citations are also an additional source of bias for the calculations of journal impact factors (Sala and Brooks, 2008). In physics, where multi-institutional groups are engaged in large research projects, multiple authorship creates a problem with the assessment of individual productivity and renders the performance of metrics based on publication and citation counts ineffective (Pritychenko, 2015). In medical publications, it was recently reported that long lists of authorship are not necessarily due to an increasing complexity of research but rather to an inherent inflationary characteristic (Tilak, Prasad, and Jena, 2015).

To solve these issues, the citation credit should be considered on a "commercial basis" (in the same way that scientific publication and citation-based metrics have been transformed into commercial activities) in the sense that the total number of citations should be shared out between shareholders (the coauthors). For example, if a publication is authored by 10 people and cited 500 times, the citation credit for each coauthor should be averaged (500/ 10 = 50) but not totally appropriated by each author individually. A single-authored paper cited 100 times should logically generate more "citation credit" for its author than the same paper shared by 10 coauthors and cited the same number of times. In other words, the "citation credits" should be shared in the same way that contributions are. However, since it is difficult to digitally quantify the contribution of each coauthor independently, the most logical option is to divide (or fraction) the total number of citations by the total number of coauthors as given in the example above. Such an option would help reduce the biases associated with long lists of honorary authorship as it would reshape the current win-win strategy of honorary authors to a low-rewarding game for each contributor (Kovacs, 2013).

Fractional citations, however, may "penalize" the first or main author in fields where academic assessment is based mainly on first authors. Full citation credit, on the other hand, attributed to all coauthors would also grant some coauthors more than their real contributions, particularly honorary authors who do little or nothing at all in a manuscript. In both cases anyway (full or averaged credits), citation-based metrics are not optimally granted, and a fair compromise is hardly applicable, suggesting that citation-based metrics are far from reliability and credibility. To allocate credit more transparently and authentically, research communities involved in large-scale collaborations need to rethink the contributorship model (Borenstein and Shamoo, 2015). A "contribution score" has recently been suggested to help authors assess their contributions based on the different phases of the preparation of a manuscript (design, data acquisition, data analysis, and manuscript writing) (Warrender, 2015). Another similar approach to quantify individual contributions was proposed based on ideas, work, writing, and stewardship (Clement, 2014).

Selective and arbitrary citations

An important, maybe the most important, bias in the citation-based bibliometrics is the absence of objective citation rules. That is, the selection of a reference for citation purposes is always subjective and arbitrary, ruled by personal appreciation and individual choices only. Authors may cite or conceal references they judge more or less appropriate for their subjects. Among a plethora of literature sources available on the same or similar topics, nothing "enforces" an author to opt for a reference more than for another, except his/her personal judgment that could be influenced by many subjective factors such as the availability of the reference to cite; the "impact factor" of the journal in which a reference is published; the celebrity of the author; the publisher; the "prestige" or reputation of a journal, maybe the author's name, gender, or country; and the easiness or difficulty of the reported information that may aid or impede the comprehension of the reported findings. At equal opportunities, it is more likely that an author cites references that are easily available and comprehensible than those unavailable or hardly comprehensible.

Finally, the flaws and disastrous effects of the impact factor (Moustafa, 2015a) apply on citation-based metrics because they are based on the same principle: the citation. As an indicator based on citation, the impact factor affects other levels besides those mentioned above: non-English speaking or least developed countries would be disadvantaged by the use of this indicator (González-Alcaide, Valderrama-Zurián, and Aleixandre-Benavent, 2012). Citation-ranking indicators and citation counts are not a reflection of scientific merit (Perneger, 2010). Citation counts often give highest ranks to the oldest or the largest journals (Garfield, 1996). Citations only display the popularity of a topic (Spier, 2009) or the visibility of an author in a citation database but not his/her real impact in the academic community (Wildgaard, 2015). Taken together, the aforementioned citation behaviors suggest that citation-based bibliometrics are unreliable, subjective, arbitrary, and non-scientific measures. The number of citations is not more than a measurable parameter—that is all it is (Spier, 2009).

Conclusion

Citations are important in the dissemination of scientific knowledge honestly and faithfully. However, the obsession with citation-based bibliometrics will exacerbate other existing deficiencies and aberrations in the scientific realms. Citation analyses are not necessarily bad in themselves, but it is the wrong use of them by evaluators and managers of science policies that make them somewhat harmful to science and scientists. Citation can generate information cascades resulting in unfounded authority of claims through distortions in its social use that include bias, invention, and amplification (Greenberg, 2009). Exaggerated and misunderstood citation values lead some people/networks to display the number of citations in their CV and/or personal profiles to present them as a sign of "scientific impact" or "excellence." The traditional citation analysis, however, is not a reliable tool for the assessment of research impact (Sarli, Dubinsky, and Holmes, 2010). Citation-based metrics do not measure the scientific quality or impact; high numbers of citations do not mean that a more cited work is assuredly of a higher quality or accuracy than a less cited work. It is not uncommon, for example, that extensively used work and highly influential articles are uncited or rarely cited (MacRoberts and MacRoberts, 2010). The appropriateness of citation-based metrics is unproven. Citation-based bibliometrics are rather strewn with many citation aberrations related to subjective, technical, and personal factors, making the value of high or low citations as untrustworthy indicators. To bestow any scientific worth to citation-based metrics, citations should be based on impartial, solid, global, and objective parameters that are currently missing, and most likely would not be available or applicable in the future due to an inherent complexity and subjectivity of the citation process. Scientists and administrators who are in charge of academic assessment should be cautious in their reliance on citation-based bibliometrics.

References

Abraham, P. 2000. Duplicate and salami publications. *Journal of Postgraduate Medicine* 46 (2):67.

Bartneck, C., and S. Kokkelmans. 2011. Detecting h-index manipulation through self-citation analysis. *Scientometrics* 87 (1):85–98. doi:10.1007/s11192-010-0306-5.

Bennett, D. M., and D. M. Taylor. 2003. Unethical practices in authorship of scientific papers. *Emergency Medicine Australasia* 15 (3):263–70. doi:10.1046/j.1442-2026.2003.00432.x.

Bird, S. J. 2002. Self-plagiarism and dual and redundant publications: What is the problem? Commentary on 'Seven ways to plagiarize: Handling real allegations of research misconduct'. *Science and Engineering Ethics* 8 (4):543–44. doi:10.1007/s11948-002-0007-4.

Borenstein, J., and A. E. Shamoo. 2015. Rethinking authorship in the era of collaborative research. *Accountability in Research* 22 (5):267–83. doi:10.1080/08989621.2014.968277.

Bozeman, B., and J. Youtie. 2015. Trouble in paradise: Problems in academic research co-authoring. *Science and Engineering Ethics*.doi:10.1007/s11948-015-9722-5.

Catalini, C., N. Lacetera, and A. Oettl. 2015. The incidence and role of negative citations in science. *Proceedings of the National Academy of Sciences of the United States of America* 112 (45):13823–26. doi:10.1073/pnas.1502280112.

Clamp, M., B. Fry, M. Kamal, X. Xie, J. Cuff, M. F. Lin, M. Kellis, K. Lindblad-Toh, and E. S. Lander. 2007. Distinguishing protein-coding and noncoding genes in the human genome. *Proceedings of the National Academy of Sciences* 104 (49):19428–33. doi:10.1073/pnas.0709013104.

Clement, T. P. 2014. Authorship matrix: A rational approach to quantify individual contributions and responsibilities in multi-author scientific articles. *Science and Engineering Ethics* 20 (2):345–61. doi:10.1007/s11948-013-9454-3.

Corbyn, Z. 2010. An easy way to boost a paper's citations. *Nature*. doi:10.1038/news.2010.406.

Cronin, B. 2001. Hyperauthorship: A postmodern perversion or evidence of a structural shift in scholarly communication practices? *Journal of the American Society for Information Science and Technology* 52 (7):558–69. doi:10.1002/(ISSN)1532-2890.

de Vasconcelos, S., and M. Roig. 2015. Prior publication and redundancy in contemporary science: Are authors and editors at the crossroads? *Science and Engineering Ethics* 21 (5):1367–78. doi:10.1007/s11948-014-9599-8.

Deloukas, P., G. D. Schuler, G. Gyapay, E. M. Beasley, C. Soderlund, P. Rodriguez-Tome, L. Hui, T. C. Matise, K. B. McKusick, J. S. Beckmann, S. Bentolila, M. Bihoreau, B. B. Birren, J. Browne, A. Butler, A. B. Castle, N. Chiannilkulchai, C. Clee, P. J. Day, A. Dehejia, T. Dibling, N. Drouot, S. Duprat, C. Fizames, S. Fox, S. Gelling, L. Green, P. Harrison, R. Hocking, E. Holloway, S. Hunt, S. Keil, P. Lijnzaad, C. Louis-Dit-Sully, J. Ma, A. Mendis, J. Miller, J. Morissette, D. Muselet, H. C. Nusbaum, A. Peck, S. Rozen, D. Simon, D. K. Slonim, R. Staples, L. D. Stein, E. A. Stewart, M. A. Suchard, T. Thangarajah, N. Vega-Czarny, C. Webber, X. Wu, J. Hudson, C. Auffray, N. Nomura, J. M. Sikela, M. H. Polymeropoulos, M. R. James, E. S. Lander, T. J. Hudson, R. M. Myers, D. R. Cox, J. Weissenbach, M. S. Boguski, and D. R. Bentley. 1998. A physical map of 30,000 human genes. *Science* 282 (5389):744–46. doi:10.1126/science.282.5389.744.

Encode Project Consortium. 2012. An integrated encyclopedia of DNA elements in the human genome. *Nature* 489 (7414):57–74.

Ezkurdia, I., D. Juan, J. M. Rodriguez, A. Frankish, M. Diekhans, J. Harrow, J. Vazquez, A. Valencia, and M. L. Tress. 2014. Multiple evidence strands suggest that there may be as few as 19 000 human protein-coding genes. *Human Molecular Genetics* 23:5866–78. doi:10.1093/hmg/ddu309.

Fenton, J. E., H. Brazier, A. De Souza, J. P. Hughes, and D. P. McShane. 2000. The accuracy of citation and quotation in otolaryngology/head and neck surgery journals1. *Clinical Otolaryngology & Allied Sciences* 25 (1):40–44. doi:10.1046/j.1365-2273.2000.00322.x.

Foley, J. A., and S. Della Sala. 2010. The impact of self-citation. *Cortex* 46 (6):802–10. doi:10.1016/j.cortex.2010.01.004.

Gami, A. S., V. M. Montori, N. L. Wilczynski, and R. B. Haynes. 2004. Author self-citation in the diabetes literature. *Canadian Medical Association Journal* 170 (13):1925–1927; discussion 1929–1930. doi:10.1503/cmaj.1031879.

Garfield, E. 1996. Fortnightly review: How can impact factors be improved? *BMJ: British Medical Journal* 313 (7054):411–13. doi:10.1136/bmj.313.7054.411.

González-Alcaide, G., J. Valderrama-Zurián, and R. Aleixandre-Benavent. 2012. The impact factor in non-English-speaking countries. *Scientometrics* 92 (2):297–311. doi:10.1007/s11192-012-0692-y.

Greenberg, S. A. 2009. How citation distortions create unfounded authority: Analysis of a citation network. *Bmj* 339:b2680–b2680. doi:10.1136/bmj.b2680.

Greenland, P., and P. B. Fontanarosa. 2012. Ending honorary authorship. *Science* 337 (6098):1019. doi:10.1126/science.1224988.

Hennessey, K. K., A. R. Williams, K. Afshar, and A. E. MacNeily. 2012. Duplicate publications: A sample of redundancy in the Journal of Urology. *Canadian Urological Association Journal* 6 (3):177–80. doi:10.5489/cuaj.

Hyland, K. 2003. Self-citation and self-reference: Credibility and promotion in academic publication. *Journal of the American Society for Information Science and Technology* 54 (3):251–59. doi:10.1002/(ISSN)1532-2890.

International Human Genome Sequencing, C. 2004. Finishing the euchromatic sequence of the human genome. *Nature* 431 (7011):931–45. doi:10.1038/nature03001.

Ioannidis, J. P. 2015. A generalized view of self-citation: Direct, co-author, collaborative, and coercive induced self-citation. *Journal of Psychosomatic Research*78 (1):7–11. doi:10.1016/j.jpsychores.2014.11.008.

Jannot, A.-S., T. Agoritsas, A. Gayet-Ageron, and T. V. Perneger. 2013. Citation bias favoring statistically significant studies was present in medical research. *Journal of Clinical Epidemiology* 66 (3):296–301. doi:10.1016/j.jclinepi.2012.09.015.

Kennedy, D. 2003. Multiple authors, multiple problems. *Science*301 (5634):733. doi:10.1126/science.301.5634.733.

Kotchoubey, B., S. Butof, and R. Sitaram. 2015. Flagrant Misconduct of Reviewers and Editor: A Case Study. *Science and Engineering Ethics* 21 (4):829–35. doi:10.1007/s11948-014-9583-3.

Kovacs, J. 2013. Honorary authorship epidemic in scholarly publications? How the current use of citation-based evaluative metrics make (pseudo)honorary authors from honest contributors of every multi-author article. *Journal of Medical Ethics* 39 (8):509–12. doi:10.1136/medethics-2012-100568.

Kulkarni, A. V., B. Aziz, I. Shams, and J. W. Busse. 2011. Author self-citation in the general medicine literature. *PLoS One* 6 (6):e20885. doi:10.1371/journal.pone.0020885.

Lander, E. S., L. M. Linton, B. Birren, C. Nusbaum, M. C. Zody, J. Baldwin, K. Devon, K. Dewar, M. Doyle, W. FitzHugh, R. Funke, D. Gage, K. Harris, A. Heaford, J. Howland, L. Kann, J. Lehoczky, R. LeVine, P. McEwan, K. McKernan, J. Meldrim, J. P. Mesirov, C. Miranda, W. Morris, J. Naylor, C. Raymond, M. Rosetti, R. Santos, A. Sheridan, C. Sougnez, N. Stange-Thomann, N. Stojanovic, A. Subramanian, D. Wyman, J. Rogers, J. Sulston, R. Ainscough, S. Beck, D. Bentley, J. Burton, C. Clee, N. Carter, A. Coulson, R. Deadman, P. Deloukas, A. Dunham, I. Dunham, R. Durbin, L. French, D. Grafham, S. Gregory, T. Hubbard, S. Humphray, A. Hunt, M. Jones, C. Lloyd, A. McMurray, L. Matthews, S. Mercer, S. Milne, J. C. Mullikin, A. Mungall, R. Plumb, M. Ross, R. Shownkeen, S. Sims, R. H. Waterston, R. K. Wilson, L. W. Hillier, J. D. McPherson, M. A. Marra, E. R. Mardis, L. A. Fulton, A. T. Chinwalla, K. H. Pepin, W. R. Gish, S. L. Chissoe, M. C. Wendl, K. D. Delehaunty, T. L. Miner, A. Delehaunty, J. B. Kramer, L. L. Cook, R. S. Fulton, D. L. Johnson, P. J. Minx, S. W. Clifton, T. Hawkins, E. Branscomb, P. Predki, P. Richardson, S. Wenning, T. Slezak, N. Doggett, J. F. Cheng, A. Olsen, S. Lucas, C. Elkin, E. Uberbacher, M. Frazier, R. A. Gibbs, D. M. Muzny, S. E. Scherer, J. B. Bouck, E. J. Sodergren, K. C. Worley, C. M. Rives, J. H. Gorrell, M. L. Metzker, S. L. Naylor, R. S. Kucherlapati, D. L. Nelson, G. M. Weinstock, Y. Sakaki, A. Fujiyama, M. Hattori, T. Yada, A. Toyoda, T. Itoh, C. Kawagoe, H. Watanabe, Y. Totoki, T. Taylor, J. Weissenbach, R. Heilig, W. Saurin, F. Artiguenave, P. Brottier, T. Bruls, E. Pelletier, C. Robert, P. Wincker, D. R. Smith, L. Doucette-Stamm, M. Rubenfield, K. Weinstock, H. M. Lee, J. Dubois, A. Rosenthal, M. Platzer, G. Nyakatura, S. Taudien, A. Rump, H. Yang, J. Yu, J. Wang, G. Huang, J. Gu, L. Hood, L. Rowen, A. Madan, S. Qin, R. W. Davis, N. A. Federspiel, A. P. Abola, M. J. Proctor, R. M. Myers, J. Schmutz, M. Dickson, J. Grimwood, D. R. Cox, M. V. Olson, R. Kaul, C. Raymond, N. Shimizu, K. Kawasaki, S. Minoshima, G. A. Evans, M. Athanasiou, R. Schultz, B. A. Roe, F. Chen, H. Pan, J. Ramser, H. Lehrach, R. Reinhardt, W. R. McCombie, M. De La Bastide, N. Dedhia, H. Blocker, K. Hornischer, G. Nordsiek, R. Agarwala, L. Aravind, J. A. Bailey, A. Bateman, S. Batzoglou, E. Birney, P. Bork, D. G. Brown, C. B. Burge, L. Cerutti, H. C. Chen, D. Church, M. Clamp, R. R. Copley, T. Doerks, S. R. Eddy, E. E. Eichler, T. S. Furey, J. Galagan, J. G. Gilbert, C. Harmon, Y. Hayashizaki, D. Haussler, H. Hermjakob, K. Hokamp, W. Jang, L. S. Johnson, T. A. Jones, S. Kasif, A. Kaspryzk, S. Kennedy, W. J. Kent, P. Kitts, E. V. Koonin, I. Korf, D. Kulp, D. Lancet, T. M. Lowe, A. McLysaght, T. Mikkelsen, J. V. Moran, N. Mulder, V. J. Pollara, C. P. Ponting, G.

Schuler, J. Schultz, G. Slater, A. F. Smit, E. Stupka, J. Szustakowski, D. Thierry-Mieg, J. Thierry-Mieg, L. Wagner, J. Wallis, R. Wheeler, A. Williams, Y. I. Wolf, K. H. Wolfe, S. P. Yang, R. F. Yeh, F. Collins, M. S. Guyer, J. Peterson, A. Felsenfeld, K. A. Wetterstrand, A. Patrinos, M. J. Morgan, P. De Jong, J. J. Catanese, K. Osoegawa, H. Shizuya, S. Choi, Y. J. Chen, and C. International Human Genome Sequencing. 2001. Initial sequencing and analysis of the human genome. *Nature* 409 (6822):860–921.

Lariviere, V., C. Ni, Y. Gingras, B. Cronin, and C. R. Sugimoto. 2013. Bibliometrics: Global gender disparities in science. *Nature* 504 (7479):211–13. doi:10.1038/504211a.

Leydesdorff, L. 2008. Caveats for the use of citation indicators in research and journal evaluations. *Journal of the American Society for Information Science and Technology* 59 (2):278–87. doi:10.1002/(ISSN)1532-2890.

Liang, F., I. Holt, G. Pertea, S. Karamycheva, S. L. Salzberg, and J. Quackenbush. 2000. Gene index analysis of the human genome estimates approximately 120,000 genes. *Nat Genet*25 (2):239–40. doi:10.1038/76126.

Lok, C. K. W., M. T. V. Chan, and I. M. Martinson. 2001. Risk factors for citation errors in peer-reviewed nursing journals. *Journal of Advanced Nursing* 34 (2):223–29. doi:10.1046/j.1365-2648.2001.01748.x.

MacRoberts, M. H., and B. MacRoberts. 1996. Problems of citation analysis. *Scientometrics* 36 (3):435–44. doi:10.1007/BF02129604.

MacRoberts, M. H., and B. R. MacRoberts. 2010. Problems of citation analysis: A study of uncited and seldom-cited influences. *Journal of the American Society for Information Science and Technology* 61 (1):1–12. doi:10.1002/asi.v61:1.

Medeiros, K. E., J. T. Mecca, C. Gibson, V. D. Giorgini, M. D. Mumford, L. Devenport, and S. Connelly. 2014. Biases in ethical decision making among university faculty. *Accountability in Research* 21 (4):218–40. doi:10.1080/08989621.2014.847670.

Moustafa, K. 2014. Don't fall in common science pitfall! *Frontiers in Plant Science* 5:536. doi:10.3389/fpls.2014.00536.

Moustafa, K. 2015a. The disaster of the impact factor. *Science and Engineering Ethics* 21 (1):139–42. doi:10.1007/s11948-014-9517-0.

Moustafa, K. 2015b. Is there bias in editorial choice? Yes. *Scientometrics* 1–3. doi:10.1007/s11192-015-1617-3.

Ngai, S., J. L. Gold, S. S. Gill, and P. A. Rochon. 2005. Haunted manuscripts: Ghost authorship in the medical literature. *Accountability in Research: Policies and Quality Assurance* 12 (2):103–14. doi:10.1080/08989620590957175.

Pennisi, E. 2003. Bioinformatics. Gene counters struggle to get the right answer. *Science* 301 (5636):1040–41. doi:10.1126/science.301.5636.1040.

Pennisi, E. 2012. Genomics. ENCODE project writes eulogy for junk DNA. *Science* 337 (6099):1159–61. doi:10.1126/science.337.6099.1159.

Perneger, T. V. 2010. Citation analysis of identical consensus statements revealed journal-related bias. *Journal of Clinical Epidemiology* 63 (6):660–64. doi:10.1016/j.jclinepi.2009.09.012.

Pritychenko, B. 2015. Fractional authorship in nuclear physics. *Scientometrics*:1–8. doi:10.1007/s11192-015-1766-4.

Quackenbush, J., F. Liang, I. Holt, G. Pertea, and J. Upton. 2000. The TIGR gene indices: Reconstruction and representation of expressed gene sequences. *Nucleic Acids Research* 28 (1):141–45. doi:10.1093/nar/28.1.141.

Resnik, D. B. 2013. Plagiarism among collaborators. *Accountability in Research* 20 (1):1–4. doi:10.1080/08989621.2013.749738.

Resnik, D. B., L. M. Rasmussen, and G. E. Kissling. 2015. An international study of research misconduct policies. *Accountability in Research* 22 (5):249–66. doi:10.1080/08989621.2014.958218.

Sala, S. D., and J. Brooks. 2008. Multi-authors' self-citation: A further impact factor bias? *Cortex* 44 (9):1139–45. doi:10.1016/j.cortex.2008.07.001.

Sarli, C. C., E. K. Dubinsky, and K. L. Holmes. 2010. Beyond citation analysis: A model for assessment of research impact. *Journal of the Medical Library Association : JMLA* 98 (1):17–23. doi:10.3163/1536-5050.98.1.008.

Schuler, G. D., M. S. Boguski, E. A. Stewart, L. D. Stein, G. Gyapay, K. Rice, R. E. White, P. Rodriguez-Tome, A. Aggarwal, E. Bajorek, S. Bentolila, B. B. Birren, A. Butler, A. B. Castle, N. Chiannilkulchai, A. Chu, C. Clee, S. Cowles, P. J. Day, T. Dibling, N. Drouot, I. Dunham, S. Duprat, C. East, C. Edwards, J. B. Fan, N. Fang, C. Fizames, C. Garrett, L. Green, D. Hadley, M. Harris, P. Harrison, S. Brady, A. Hicks, E. Holloway, L. Hui, S. Hussain, C. Louis-Dit-Sully, J. Ma, A. MacGilvery, C. Mader, A. Maratukulam, T. C. Matise, K. B. McKusick, J. Morissette, A. Mungall, D. Muselet, H. C. Nusbaum, D. C. Page, A. Peck, S. Perkins, M. Piercy, F. Qin, J. Quackenbush, S. Ranby, T. Reif, S. Rozen, C. Sanders, X. She, J. Silva, D. K. Slonim, C. Soderlund, W. L. Sun, P. Tabar, T. Thangarajah, N. Vega-Czarny, D. Vollrath, S. Voyticky, T. Wilmer, X. Wu, M. D. Adams, C. Auffray, N. A. Walter, R. Brandon, A. Dehejia, P. N. Goodfellow, R. Houlgatte, J. R. HudsonJr., S. E. Ide, K. R. Iorio, W. Y. Lee, N. Seki, T. Nagase, K. Ishikawa, N. Nomura, C. Phillips, M. H. Polymeropoulos, M. Sandusky, K. Schmitt, R. Berry, K. Swanson, R. Torres, J. C. Venter, J. M. Sikela, J. S. Beckmann, J. Weissenbach, R. M. Myers, D. R. Cox, M. R. James, D. Bentley, P. Deloukas, E. S. Lander, and T. J. Hudson. 1996. A gene map of the human genome. *Science* 274 (5287):540–46.

Seeman, J. I., and M. C. House. 2010. Influences on authorship issues: An evaluation of receiving, not receiving, and rejecting credit. *Accountability in Research* 17 (4):176–97. doi:10.1080/08989621.2010.493094.

Seeman, J. I., and M. C. House. 2015. Authorship issues and conflict in the U.S. academic chemical community. *Accountability in Research* 22 (6):346–83. doi:10.1080/08989621.2015.1047707.

Song, F., S. Parekh, L. Hooper, Y. K. Loke, J. Ryder, A. J. Sutton, C. Hing, C. S. Kwok, C. Pang, and I. Harvey. 2010. Dissemination and publication of research findings: An updated review of related biases. *Health Technol Assess* 14 (8):iii, ix–xi, 1–193. doi:10.3310/hta14080.

Spier, R. 2009. On the ethics of using citation indices in evaluations. *Science and Engineering Ethics* 15 (1):1–2. doi:10.1007/s11948-009-9115-8.

Spier, R. E., and S. J. Bird. 2000. Scientific misconduct: Ongoing developments. *Science and Engineering Ethics* 6 (1):3–4. doi:10.1007/s11948-000-0016-0.

Spier, R. E., and G. A. Poland. 2013. What is excellent science and how does it relate to what we publish in vaccine? *Vaccine* 31 (45):5147–48. doi:10.1016/j.vaccine.2013.08.049.

Taylor, D. M. 2002. The appropriate use of references in a scientific research paper. *Emergency Medicine Australasia* 14 (2):166–70. doi:10.1046/j.1442-2026.2002.00312.x.

Tilak, G., V. Prasad, and A. B. Jena. 2015. Authorship inflation in medical publications. *Inquiry* 52.doi:10.1177/0046958015598311.

van Wesel, M. 2015. Evaluation by citation: Trends in publication behavior, evaluation criteria, and the strive for high impact publications. *Science and Engineering Ethics* . doi:10.1007/s11948-015-9638-0.

Venter, J. C., M. D. Adams, E. W. Myers, P. W. Li, R. J. Mural, G. G. Sutton, H. O. Smith, M. Yandell, C. A. Evans, R. A. Holt, J. D. Gocayne, P. Amanatides, R. M. Ballew, D. H. Huson, J. R. Wortman, Q. Zhang, C. D. Kodira, X. H. Zheng, L. Chen, M. Skupski, G. Subramanian, P. D. Thomas, J. Zhang, G. L. Gabor Miklos, C. Nelson, S. Broder, A. G. Clark, J. Nadeau, V. A. McKusick, N. Zinder, A. J. Levine, R. J. Roberts, M. Simon, C. Slayman, M. Hunkapiller, R. Bolanos, A. Delcher, I. Dew, D. Fasulo, M. Flanigan, L. Florea,

A. Halpern, S. Hannenhalli, S. Kravitz, S. Levy, C. Mobarry, K. Reinert, K. Remington, J. Abu-Threideh, E. Beasley, K. Biddick, V. Bonazzi, R. Brandon, M. Cargill, I. Chandramouliswaran, R. Charlab, K. Chaturvedi, Z. Deng, V. Di Francesco, P. Dunn, K. Eilbeck, C. Evangelista, A. E. Gabrielian, W. Gan, W. Ge, F. Gong, Z. Gu, P. Guan, T. J. Heiman, M. E. Higgins, R. R. Ji, Z. Ke, K. A. Ketchum, Z. Lai, Y. Lei, Z. Li, J. Li, Y. Liang, X. Lin, F. Lu, G. V. Merkulov, N. Milshina, H. M. Moore, A. K. Naik, V. A. Narayan, B. Neelam, D. Nusskern, D. B. Rusch, S. Salzberg, W. Shao, B. Shue, J. Sun, Z. Wang, A. Wang, X. Wang, J. Wang, M. Wei, R. Wides, C. Xiao, C. Yan, A. Yao, J. Ye, M. Zhan, W. Zhang, H. Zhang, Q. Zhao, L. Zheng, F. Zhong, W. Zhong, S. Zhu, S. Zhao, D. Gilbert, S. Baumhueter, G. Spier, C. Carter, A. Cravchik, T. Woodage, F. Ali, H. An, A. Awe, D. Baldwin, H. Baden, M. Barnstead, I. Barrow, K. Beeson, D. Busam, A. Carver, A. Center, M. L. Cheng, L. Curry, S. Danaher, L. Davenport, R. Desilets, S. Dietz, K. Dodson, L. Doup, S. Ferriera, N. Garg, A. Gluecksmann, B. Hart, J. Haynes, C. Haynes, C. Heiner, S. Hladun, D. Hostin, J. Houck, T. Howland, C. Ibegwam, J. Johnson, F. Kalush, L. Kline, S. Koduru, A. Love, F. Mann, D. May, S. McCawley, T. McIntosh, I. McMullen, M. Moy, L. Moy, B. Murphy, K. Nelson, C. Pfannkoch, E. Pratts, V. Puri, H. Qureshi, M. Reardon, R. Rodriguez, Y. H. Rogers, D. Romblad, B. Ruhfel, R. Scott, C. Sitter, M. Smallwood, E. Stewart, R. Strong, E. Suh, R. Thomas, N. N. Tint, S. Tse, C. Vech, G. Wang, J. Wetter, S. Williams, M. Williams, S. Windsor, E. Winn-Deen, K. Wolfe, J. Zaveri, K. Zaveri, J. F. Abril, R. Guigo, M. J. Campbell, K. V. Sjolander, B. Karlak, A. Kejariwal, H. Mi, B. Lazareva, T. Hatton, A. Narechania, K. Diemer, A. Muruganujan, N. Guo, S. Sato, V. Bafna, S. Istrail, R. Lippert, R. Schwartz, B. Walenz, S. Yooseph, D. Allen, A. Basu, J. Baxendale, L. Blick, M. Caminha, J. Carnes-Stine, P. Caulk, Y. H. Chiang, M. Coyne, C. Dahlke, A. Mays, M. Dombroski, M. Donnelly, D. Ely, S. Esparham, C. Fosler, H. Gire, S. Glanowski, K. Glasser, A. Glodek, M. Gorokhov, K. Graham, B. Gropman, M. Harris, J. Heil, S. Henderson, J. Hoover, D. Jennings, C. Jordan, J. Jordan, J. Kasha, L. Kagan, C. Kraft, A. Levitsky, M. Lewis, X. Liu, J. Lopez, D. Ma, W. Majoros, J. McDaniel, S. Murphy, M. Newman, T. Nguyen, N. Nguyen, M. Nodell, S. Pan, J. Peck, M. Peterson, W. Rowe, R. Sanders, J. Scott, M. Simpson, T. Smith, A. Sprague, T. Stockwell, R. Turner, E. Venter, M. Wang, M. Wen, D. Wu, M. Wu, A. Xia, A. Zandieh, and X. Zhu. 2001. The sequence of the human genome. *Science* 291 (5507):1304–51. doi:10.1126/science.1058040.

Vickers, M. D. 1995. Citation errors — There is still much to be done. *Canadian Journal of Anaesthesia* 42 (11):1063–1063. doi:10.1007/BF03011085.

Warrender, J. M. 2015. A simple framework for evaluating authorial contributions for scientific publications. *Science and Engineering Ethics*.doi:10.1007/s11948-015-9719-0.

Wildgaard, L. 2015. A comparison of 17 author-level bibliometric indicators for researchers in astronomy, environmental science, philosophy and public health in web of science and google scholar. *Scientometrics* 1–34. doi:10.1007/s11192-015-1608-4.

Wislar, J. S., A. Flanagin, P. B. Fontanarosa, and C. D. Deangelis. 2011. Honorary and ghost authorship in high impact biomedical journals: A cross sectional survey. *BMJ* 343:d6128. doi:10.1136/bmj.d6128.