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Commentary

A generalized view of self-citation: Direct, co-author, collaborative, and coercive induced self-citation

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A B S T R A C T

The phenomenon of self-citation can present in many different forms, including direct, co-author, collaborative, and coercive induced self-citation. It can also pertain to the citation of single scientists, groups of scientists, journals, and institutions. This article presents some case studies of extreme self-citation practices. It also discusses the implications of different types of self-citation. Self-citation is not necessarily inappropriate by default. In fact, usually it is fully appropriate but often it is even necessary. Conversely, inappropriate self-citation practices may be highly misleading and may distort the scientific literature. Coercive induced self-citation is the most difficult to discover. Coercive Induced self-citation may happen directly from reviewers of articles, but also indirectly from reviewers of grants, scientific advisors who steer a research agenda, and leaders of funding agencies who may espouse spending disproportionately large funds in research domains that perpetuate their own self-legacy. Inappropriate self-citation can be only a surrogate marker of what might be much greater distortions of the scientific corpus towards conformity to specific opinions and biases. Inappropriate self-citations eventually affect also impact metrics. Different impact metrics vary in the extent to which they can be gamed through self-citation practices. Citation indices that are more gaming-proof are available and should be more widely used. We need more empirical studies to dissect the impact of different types of inappropriate self-citation and to examine the effectiveness of interventions to limit them.

Introduction

Self-citation is an interesting feature of scientific discourse. While the typical paradigm is direct self-citation from an author to his/her own work, there are many other forms where self-referential motives exist, often in a not easily recognizable manner. Table 1 presents four case studies that offer a sense of the wide breadth, variety, and potential impact of self-citation phenomena [1–8]. Here, I will try to review the different types of self-citation (Table 2) along with potential challenges that they create.

Direct self-citation

The classic type of self-citation is direct self-citation. The author cites his/her previous work in subsequent scholarly works. The prevalence of direct self-citations varies across authors, journals, scientific fields, countries, rank, and age of the scientists and it is relatively more prominent in the few years after the publication of a paper. There is already a rich literature on direct self-citation, e.g. see [9–19]. Thomson Reuters Web of Science readily generates citation counts for all citations and excluding direct self-citations.

Co-author and collaborative self-citation

In co-author self-citation, one or more co-author(s) of scientist Y write another paper without Y and that paper cites their common paper [20]. These are direct self-citations for the co-author(s), but the scientist of interest has not directly self-cited himself/herself. This process can take substantial dimensions, especially when there are many co-authors. There is some correlation between the number of co-authors and proportion of self-citations [21]. Scopus readily generates citation counts for all citations and excluding both direct self-citations and co-author self-citations.

A further possibility arises when scientists participate in large densely-connected collaborative teams that publish many papers within the framework of their collaboration, with only a subset of the investigators represented as authors in each of these papers. Each of these papers may cite many papers by the same collaborative team. For a given scientist, some of these citations will look as direct self-citations (scientist Y self-citing another paper where Y is an author), others will

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Table 1
Some case studies of self-citation.

Case study 1. The 14th scientist in impact in Medicine in 2008–2012
According to Microsoft Academic Search, 2,066,208 scientists have published papers in Medicine in the last 5 years (2008–2012, given last database update in 2012). #14 in impact rank (h-index) is D.H. Roukos (http://academic.research.microsoft.com/RankList?entitytype=2&topdomainid=6&subdomainid=0&last=5). Independently verified, according to Scopus, that author has h-index = 68 and 7045 citations as of October 18, 2014. Typically for h = 68 one would expect a total of citations roughly 3–5 times the h^2 [1], i.e. 2–4 times as many citations. However, no paper is very highly-cited (the most-cited one has 165 citations in Scopus) and after the top-70 cited papers, citations for the other papers fall sharply. This citation pattern optimizes the h-index. The majority of the citations come either from a core of self-citing papers (137 self-citing papers) or from very few colleagues such as Ziogas D (trainee of Roukos, 69 mentor-citing papers) or Hottenrott C (mentor of Roukos, 51 mentee-citing papers) and a few others. The majority of these papers are letters or editorials/comments with very long lists of citations to Roukos. For example, the last English-language Scopus-indexed paper by Christ of Hottenrott in the 20th century was in 1994, then he published 5 more German-language Scopus-indexed papers in 1999–2002 and nothing that was Scopus-indexed in 2003–2007. Then apparently after 2008, he published within 6 years over 50 letters/comments that extensively cite Roukos. For example, the latest 3 published letters/comments of Hottenrott [2–4] cite 37, 32, and 32 items, respectively, of which 31, 26, and 25 (consistently over 80% of the cited references) are by Roukos. Overall, the recent letters of Hottenrott cite Roukos over a thousand times. The corresponding author e-mail for Hottenrott is the e-mail of a website launched by Roukos (info@gastricbreastcancer.com). Interestingly, Roukos papers typically do not cite Hottenrott papers.
Case study 2. One of the top-10 most-cited papers in 2010–2011 among papers published in 2009
The paper by the editor-in-chief AJS Coates on "Ethical authorship and publishing" was published in 2009 in the International Journal of Cardiology (IJC) and it has received 1615 citations by October 2014 in Scopus. It received 796 citations in 2010 and 587 citations in 2011, making it one of the top-10 most-cited papers across the entire scientific literature among the 2,246,377 papers published in 2009. Then it tapered to 128 citations in 2012, 8 in 2013, and 6 in 2014. The paper is a little over 1 page and it only contains the short statement of authorship that IJC is asking of all its authors to place in their papers along with citing that reference. 1555 of the 1615 citations (97%) are from papers published in IJC. Given that all IJC papers had to cite this article in the two years that count towards the impact factor calculation, IJC gained almost 1 point in impact factor by this paper alone. In 2010 a new version of "Ethics in the authorship and publishing of scientific articles" was publishing in the same journal and was cited mostly in 2011 and 2012 (668 citations-to-date). These are by far the two most-cited papers in the entire publication history of IJC. A newer version on "Statement on authorship and publishing ethics in the International Journal of Cardiology" was published in 2011 and was cited mostly in 2012 and 2013 (173 citations to-date). Opthof has estimated [5] that the 2010 impact factor of IJC increased by 57% from self-citations. The impact factor calculation is based on the citations received by papers published in the previous two years, thus as the journal self-cited paper was re-published every year, this maintained boosting of the impact factor.
Case study 3. The university with the highest number of highly-cited faculty in the world
According to the highly reliable database of Highly-Cited Researchers issued by Thomson Reuters in 2014 (www.highlycited.com), the university that has the highest number of highly-cited researchers among its faculty in the whole world is King Abdulaziz University in Saudi Arabia: 160 highly-cited researchers have declared this university as their primary or secondary affiliation, followed by 146 for Harvard, 97 for NIH, and 60 for Stanford [6]. King Abdulaziz would become second in rank only if all University of California campuses were merged (176 highly-cited researchers). The number of highly-cited faculty is one of the key criteria for ranking universities by the Shanghai system for world ranking of universities. Not surprisingly, given its outstanding performance in this metric alone, King Abdulaziz is ranked 10th in Mathematics in the world (better than MIT) and 38th in Chemistry (http://www.shanghairanking.com/World-University-Rankings/King-Abdulaziz-University.html). Bhattacharjee [7] has alerted the scientific community that Saudi Arabian universities offer highly-cited researchers financially lucrative contracts in which the researchers commit themselves to citing the Saudi Arabian university as one of their institutional affiliations in their publications or on highlycited.com.
Case study 4. Ike Ankara, a scientist more cited than Albert Einstein
In 2010, Cyril Labbe used the software scigen to generate 110 fictitious papers supposedly authored by Ike Antkare [8]. Each of these papers included self-citations to the other papers of Ike Antkare. As a result Ike Antkare obtained such a citation presence in Google Scholar that the software Scholarometer gave him an h-index of 94, making him one of the most cited scientists of all times, way ahead of poor Albert Einstein who only had h = 84 at that time [8].

look as co-author self-citations (some team scientist(s) authoring a paper without scientist Y and self-citing a paper where both this team scientist(s) and Y are authors), and some others will be neither (some team scientist(s) authoring a paper within the same collaboration framework without scientist Y and citing a paper where Y but not this team scientist(s) is an author). This latter category may be called collaborative self-citation.

Table 2
Classification of types of self-citation: a generalized view.

According to who cites whom and where
Direct self-citation
Co-author self-citation
Collaborative self-citation
Coercive induced self-citation
By peer-reviewers of single papers
By editors of journals
By peer-reviewers of grants
By scientific advisors of research agendas
By leaders of funding agencies
By institutions (listing of institutional affiliations)
According to beneficiary of self-citation
Single scientist
Groups of scientists
Journals
Institutions
According to nature of citing unit
Citing papers are genuine
Fabricated citing papers
According to appropriateness
Appropriate
Inappropriate

Collaborator networks can be anywhere from very small to very large. In case study 1 (Table 1), the citing collaborator network is very small and the published products of the collaboration network are primarily citation-loaded letters/comments. Large collaborator networks are becoming frequent in many domains. For example, a search for "European Prospective Investigation into Cancer and Nutrition" (EPIC) in title/abstract/keyword in Scopus (October 26, 2014) yields 978 papers by this prolific collaborative group. A total of 159 authors have authored at least 25 of the 978 papers. Only 9 authors have co-authored more than a quarter of the 978 papers (range 304–447 EPIC papers co-authored by these 9 scientists). EPIC papers unavoidably cross-cite previous EPIC papers. In physics, Thomson Reuters had to revise its rules for identifying Highly-Cited Researchers (www.highlycited.org) and to exclude papers with over 500 authors, because otherwise all highly-cited authors would be selected from the collaborator network centered at CERN where typically hundreds of authors appear in each paper.

Coercive induced self-citation

In coercive induced self-citation, the citing scientists are neither co-authors nor collaborators of the cited scientist [22,23]. They are induced to cite a paper with some degree of coercive pressure: they face potential negative consequences unless they cite the paper and/or they expect rewards if they cite it. Coercive induced self-citation cannot be detected

by readers of the eventually published papers. The study of Thombs et al. [24] is very important because it probes from an insider view how common it is for peer reviewers to request (in asking revisions) that their papers should be cited by revising authors. Apparently a third of the requested citations-to-add are papers that the reviewer has written especially when the reviewers are not rejecting the paper. Other types of similar coercion may occur from other people-in-power such as editors asking for citations to be added to their work or to the work published by their journal [25–28]. Journals may boost their impact factor by inducing the citation of items published in the previous two years, as in case study 2 (Table 1). Thomson Reuters also allows calculating an impact factor excluding journal self-cites, but this corrected estimate has not gained traction until now.

Generalizing the concept of coercive induced self-citation

More generally, coercive induced self-citation may occur at many other levels and may be exercised by grant reviewers, institutions, and scientific leaders who steer research agendas and the allocation of research funds. For example, grant reviewers may select for funding applications in a way that they are aligned with their own theories or findings, in the same field where they also work [29]. They may also ask for specific revisions that align the work to their own legacy as a prerequisite for funding. Universities and other institutions may offer financial incentives for their name to be listed in publications and highly-cited scientist databases, such as in the case of King Abdulaziz University which surprisingly has the highest number of highly-cited scientists in the world than any other university [1,2] (case study 3 in Table 1). Scientific advisors and scientist-leaders of major funding agencies may exercise indirectly a form of coercive self-citation if they promote disproportionate funding for scientific domains that are aligned with their personal legacy at the expense of neglecting other important lines of investigation.

Industrial-scale self-citation and fabricated papers

A self-referential industry may sometimes sacrifice the quality of the self-citing units. For example, scientists or even large collaborative teams may adopt salami publication and least publishable unit strategies to increase numbers of publications and (self)-citations. While the example of the highly-cited but fictitious Ike Antkare (case study 4 in Table 1) is extreme, fabricated nonsensical papers (perhaps even with fictitious authors) probably do exist in the mainstream literature [30]. One hopes that they are uncommon. A hoax experiment has shown that current peer-review standards in many journals are unable to reject fabricated papers even when they are loaded with major flaws [31].

Is there a problem? Appropriate self-citation versus distortion of science

Self-citation cannot be condemned by default. Self-citation is usually fully appropriate, since an author indeed needs to present fairly and accurately previous work that he/she or his co-authors or collaborators have performed. In fact, non-use of appropriate self-citation is even unethical sometimes, e.g. when reference to prior work is eliminated in an effort to conceal that the new work is not as novel as it is claimed. There is extensive evidence on how poor the citation of prior work is in the scientific literature [32–34]. Journals may rightly promote the use of some standards that they have published, e.g. meticulous standards for better reporting of research, and ask for compliance with and reference to them. Journal self-cites are often fully appropriate and in specialty fields with few journals relatively high journal self-cite rates are unavoidable. Properly conducted team science is highly desirable and can improve the efficiency and reproducibility record of many scientific fields. Co-authoring papers with many different scientists in different fields is typically a sign of a good scientist with broad appeal and interdisciplinarity. Institutions should take credit for and pride in their high-impact work and stellar scientists. Moreover, leading researchers should feel free to express their views on what science they consider meritorious — and to believe that their field is important.

However, self-citation may also be inappropriate, excessive, unbalanced (promoting one particular view, and the work of one author or team or school of thought), inbred (promoting one or more connected people), misleading and distorting. Erroneous theories and beliefs can be propagated by citation networks that emphasize statements that are clearly wrong or even refuted by empirical evidence [35]. Refuted claims continue to be heavily cited once entrenched in the literature [36]. In this regard, the different variants of self-citation can be surrogates of a deeper and more troubling potential distortion of the scientific literature.

Self-citation acts as an advertising tool. Directly self-citing authors strengthen their positioning and the greater visibility of their work leads also to more citations by other independent authors [37]. Collaborative teams have even more power to mold a field according to their preferences through co-author and collaborative self-citation, which again is just a marker of these preferences. Coercive induced self-citation is even more subversive, since scientists are forced to adhere to a given theory or interpretation against their wishes [38]. Thombs et al. [24] investigated whether the requests by referees for induced self-citations were reasonable, i.e. whether there was any rationale presented by the reviewers in requesting added citations. In the large majority, some rationale was listed, and eventually very few coercive induced self-citations appeared in the published papers without any rationale. However, the definition of what would count as "rationale" was very lenient. The presented rationale could be practically anything. This does not guarantee by any means that the rationale was reasonable. Among scientific advisors or funders, some wordsmithing can always excuse why billions of dollars need to be spent on some top-priority, even if the "top-priority" is just an uninformative bubble.

Moreover, it is unknown in how many cases peer-reviewers ask for revisions that make the paper better aligned with and supportive of their own beliefs and theories, even without asking for any explicit self-citations to be added in the revision. Similarly, advisors and funders are not promoting their pet scientific fields primarily because they want to induce self-citations. Self-citations here is only one of the many byproducts of making one belief, theory, or discipline more visible and thriving. Some pathways are intended directly to generate citations whereas others have the effect of increasing citations as a byproduct of broad manipulation of the scientific agenda.

Self-citations and impact indices

A second issue with self-citations has to do with the assessment of scientific impact. Impact indices may be affected by self-citations of all types boosting the ranking of scientists, groups, journals, or institutions. The fact that deliberate efforts are made to game impact indices suggests that these indices do have perceived value among science stakeholders. If they had no perceived value, there would have been no incentive to game them. When the reward system depends on spuriously inflated indices, the distortions could have an impact on deciding promotions, funding, and other rewards. The relative efficiency of different self-citation types to distort indices needs better study. However, based on the data of Thombs et al. [24] it seems unlikely that coercive induced self-citation during the review of single papers can boost a lot the citation indices of the reviewers, except for "missionary" reviewers who undertake many reviews per month and every time they demand that many of their papers should be cited. Eventually, one has to differentiate again between appropriate and inappropriate self-citations and this is often difficult, as discussed above.

Table 3
Impact indices in decreasing potential for gaming.

Impact index	Potential for gaming: comments
1. Number of publications	Extremely high: anything can be published nowadays, and salami publication and least publishable unit practices are widespread
2. Cumulative impact factor	Very high: many low-quality journals have substantially high impact factors, journal impact factor says almost nothing about the quality of a single paper and gives very little information even for the citation impact of a specific paper ("20/80 rule")
3. Total count of citations or H-index	Modest: especially for scientists with limited citation counts, self-citation practices can make a difference; usually this is less of an issue with extremely high citation counts
4. Co-authorship-adjusted citation indices, e.g. Schreiber hm or harmonic adjustments for author positions	Limited to modest: can correct for the extent of multi-authorship, may also diminish the impact of collaborative self-citation [39,40], may differentiate nuclear authors from collaborative authors [41]; ideally one would like to know exact contributions in each paper, but this is still not common
5. Combination of H-index, co-authorship-adjusted citation indices, and total citation count	Limited: a combination of indices can discern better anomalous, spurious patterns suggesting gaming
6. The above, excluding different types of self-citation or correcting for them	Limited: excluding self-citations is not better than including self-citations, when self-citations are appropriate, but it is useful if there is a concern about the impact of inappropriate self-citations; several correction methods exist for specific indices and for detecting their manipulation, e.g. see [42–44]
7. The above, plus in-depth scrutiny of single papers that have received a very high number of citations by diverse other scientists in diverse journals	Very limited: a scientist who publishes specific papers, especially as first or senior author, with tremendous citation impact (e.g. in the top 1% or even 0.1% of the field) must have done something very influential; of course, still these papers may not necessarily be "correct", but they can be scrutinized in depth for their merits
8. The above plus consideration of other dimensions of the work, such indices of study design quality, reproducibility, data sharing, and translational impact.	Very limited: see for example, the proposed PQRST index [45]

Gaming-proof impact indices

Impact indices vary in the extent to which they can be gamed and in the extent to which gaming is visible (and thus correctable) once it has occurred. Extreme cases are didactic, but don't represent the majority of less conspicuous gaming. Extreme cases are also easily visible. However, how about the more modest, less readily perceptible changes? Ideally, we should prefer gaming-proof indices over others that are easy to manipulate. Table 3 shows a list of impact indices for a scientist in decreasing potential for gaming [39–45].

Citation indices, especially those that are least prone to gaming and combinations thereof, do have discriminating ability and utility in appraising science. In fact, probably they are the best "bronze" standard that we have at the moment. Nothing is perfect. E.g. citation indices are more informative than Nobel prizes [46], the most prestigious award recognition. Most scientists who do very important work never get a Nobel prize but do have favorable citation indices, thus citation indices have superior sensitivity. While some highly-cited scientists may not be doing very important work, combinations of more gaming-proof indices can offer transparent information on how/why a scientist is cited and by whom. Nobel prizes may have better specificity, but even they are not perfect, e.g. a Nobel prize was awarded to Moniz in 1949 for prefrontal leukotomy. Combinations of difficult-to-game citation indices probably have also better discriminating performance than other subjective qualitative evaluations (promotions, other awards, elections in honorific bodies, etc.). Of course, lobbying and gaming is possible, if not common, also in such qualitative evaluations [47]. Moreover, citation indices are now widely available, so evaluators do see them, regardless of whether they admit to using them officially or not. Instead of criticizing citation indices, we need to use those that are more gaming-proof.

What is next?

Overall, self-citations are an interesting modulating variable in the evolution of science. Different potential interventions can be conceived to reduce inappropriate self-citations of various types. For coercive induced self-citations during peer review, Thombs et al. [24] propose more stringency in the instructions to the authors asking for provision of rationale when self-citations are requested by reviewers. It is unknown whether this policy would abort inappropriate induced self-citations, since, as I mentioned above, some rationale can always be invoked. Another possibility is to make peer-review open with posting of the reviewer comments online and revealing the reviewers' names in public [48]. Pros and cons of open peer review have long been debated and a full overview of relevant empirical studies is beyond the scope of this paper. A compromise for those who object to unmasking of names would be making the comments publicly available without necessarily unmasking the names of the reviewers. It is unknown though whether this policy would "shame" inappropriate reviewers from making requests for inappropriate induced self-citations.

In all, perhaps we should worry less about whether self-citations may inappropriately boost some game-prone citation indices and more about this process being only a symptom of a much greater problem with spuriously induced conformity in the scientific literature. Revealing the depth of the problem in more transparent ways and identifying interventions to diminish it should be the focus of future empirical studies.

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