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Self-citation: comparison between Radiology, European Radiology and Radiology for 1997–1998

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Abstract This study investigates the incidence of self-citation (authors citing their own work) for scholarly articles in ten journals published by the American Physiological Society. We analysed authorship and referencing practices of all original research articles published in the first ordinary issue of each journal in both 2000 and 2010, comprising 271 and 212 articles, respectively. Self-citation is common in these journals and represents a total of 17.75% of all citations. Only 9 (1.86%) of the articles analysed did not self-cite. Author position significantly influenced the rate of self-citation with last authors being self-cited significantly more than any other author. This was likely a result of the cumulative nature of scientific research within a specific discipline and the necessary desire to promote ones own work for associated academic benefit. The country in which the work was conducted also influenced the rate of self-citation, with last authors based in North America self-citing more than last authors from Asian countries. A comparison of self-citation rates between decades (2000 and 2010) revealed an increase in the number of authors and number of citations per article between 2000 and 2010, however the mean percentage of self-cited articles did not differ between the years. Finally, there were no differences in the percentage of self-citation between the different journals analysed.

Keywords Self-citation · American Physiological Society journals · Bibliometric analysis

Introduction

Citation rates of scientific publications are commonly used for assessing the impact of individual authors, institutions and journals on the scientific community (Falagas and

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Kavvadia 2006). Higher citation rates may improve the chances of an individual receiving grant funding, academic appointment or salary increases (Foley and Della Sala 2010), or may increase the readership and subscription base of a journal. Citation rates per se, and citation indices calculated from them (such as the *h* index; (Engqvist and Frommon 2008; Vanclay 2007)) are thought to give an estimate of both the quality and quantity of an author's work. As a result of this, a strategic incentive exists for researchers to cite themselves (Lawani 2007), or "eigenlob" (Falagas and Kavvadia 2006) thus allowing the construction of professional credibility (Hyland 2003) and promotion of their own career, sometimes disproportionally to the importance of the work itself (Fowler and Aksnes 2007). In this context, a self-citation is commonly defined as a "citation in which the citing and the cited paper have at least one author in common" (Aksnes 2003). In addition to self-promotion of earlier work and egotism/self aggrandizement (Hyland 2003), self-citation, to some extent, may simply be due to the cumulative nature of science, whereby researchers publish more as time and their careers progress (Aksnes 2003). It follows from this that more senior authors should show greater rates of self-citation than junior authors. Additionally, self-citation may be further justified when the articles are in a series, or when authors refer to previously used methodologies (Falagas and Kavvadia 2006). In this way, a proportion of self-citations, particularly those of senior authors, could be considered conventional and acceptable (Phelan 1999). Despite this proportion of "legitimate" self-citations, it has been suggested that some authors excessively self-cite and as a result, all self-citations should be removed from citation rates, and indices of scientific achievement (Schreiber 2007). This is due to the impossibility of identifying or classifying justified self-citations, and also because of the knowledge that the impact of self-citation is not limited to the citations themselves. For instance, self-citation of work that also involves additional authors increases the number of citations of those authors, arguably without true justification (Foley and Della Sala 2010).

Thus, there is continuing controversy among scientists regarding self-citation and its contribution to academic recognition and how this should be addressed with respect to measures of scientific impact. Surprisingly, however, there have been relatively few analyses examining the extent of self-citation (Falagas and Kavvadia 2006), and none within the field of physiology. The main aim of this study, therefore, was to contribute to the growing body of data on self-citation, with particular reference to research articles published in the journals of the American Physiological Society. We achieved this by analysing 483 articles published within ten separate, peer reviewed scientific journals. Further, we investigated self-citation patterns between decades (2000 and 2010) to assess changes over time and, finally, we analysed whether the country in which the authors were based influenced the rate of self-citation.

Source, data and methods

The prevalence of self-citation within the field of physiology was assessed through the examination of original research articles, published within ten leading international physiology journals. The American Physiological Society publishes 14 scholarly publications of which ten contain original research articles. Seven of these ten journals come under the "American Journal of Physiology (AJP)" banner. The ten journals we analysed were (1) *AJP—Cell Physiology*, (2) *AJP—Endocrinology and Metabolism*, (3) *AJP—Gastrointestinal and Liver Physiology*, (4) *AJP—Heart and Circulatory Physiology*, (5) *AJP—Lung Cellular and Molecular Physiology*, (6) *AJP—Regulatory, Integrative and*

Comparative Physiology, (7) *AJP—Renal Physiology*, (8) *Physiological Genomics*, (9) *Journal of Applied Physiology* and (10) *Journal of Neurophysiology*.

From each of these journals we selected the first issue of both 2000 and 2010 that was not a special issue, making for a total of 20 issues analysed. Within issues, data were extracted from original research articles only (review articles, editorials, letters to the editor, rapid communications etc. were excluded). This made for a total of 483 articles analysed. Data extracted from each article included journal name, name of first author, number of authors, number of references, number and percentage of self-citations for each author (with particular reference to the first and last (senior) authors), number and percentage of references that cite any of the authors, number of times author names appear in the citations, author position with the greatest number of self-citations, and country of the first and last authors. Bibliometric data were obtained from the respective journal websites. Descriptive statistical analysis of the distribution of these variables was conducted using Microsoft Excel (v2003 Microsoft Coroporation, Redmond WA, UWA) to obtain a snapshot picture of the incidence of self-citation for original research articles published by the American Physiological Society over the last decade. Appropriate statistical analyses were conducted using SigmaPlot (v11 SPSS Science, Chicago, IL, USA). Data are presented as mean ± standard deviation.

Results

Basic journal statistics

We analysed a total of 483 research articles (271 from 2000 and 212 from 2010). The overall average number of authors on these articles was 4.71 ± 2.34. The number of authors per article was significantly higher in 2010 (5.29 ± 2.70, range 1–19) compared to 2000 (4.25 ± 1.90, range 1–11; Mann–Whitney U test, $T = 57550.0$, $df = 481$, $p < 0.001$; Fig. 1). Similarly, the number of references cited per article increased from 40.64 ± 15.40 (maximum 126, minimum 12) in 2000 to 49.50 ± 18.90 (maximum 185, minimum 18) in 2010 (Mann–Whitney U test, $T = 60614.5$, $df = 481$, $p < 0.001$). The overall average number of references per article was 44.52 ± 17.56.

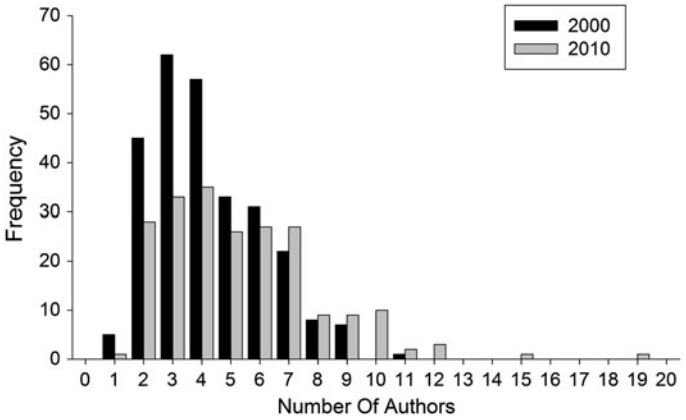

Fig. 1 The number of authors per article in American Physiological Society journals in 2000 and 2010

Table 1 First and last author nationalities, based on author address for selected American Physiological Society journals published in 2000 and 2010

Country	% First author	% Last author
United States	60.2	61.3
Canada	8.1	8.1
Japan	5.8	5.2
Denmark	2.7	2.5
France	2.7	2.7
Germany	2.5	2.7
United Kingdom	2.5	2.7
The Netherlands	2.3	2.3
Australia	1.9	1.9
Sweden	1.9	1.4
Belgium	1.4	1.4
Italy	1.4	1.4
China	1.0	1.0
Israel	0.8	0.6
Spain	0.8	0.6
Brazil	0.6	0.4
Ireland	0.6	0.8
South Korea	0.6	0.6
Switzerland	0.6	0.6
Finland	0.4	0.4
Mexico	0.4	0.4
Taiwan	0.4	0.4
Norway	0.2	0.2
Qatar	0.0	0.2

The greatest number of first and last authors state their location as the United States (Table 1; 60.25 and 61.28% respectively). The next most highly reported countries of origin were Canada (8.07% first authors, 8.07% last authors) and Japan (5.80% first authors, 5.18% last authors). The remaining $\sim$25% of first and last authors were fairly evenly distributed from 21 other countries spread across all continents except Africa.

Self-citation

Self-citation was prevalent in all journals in both years sampled. Journal specific data are shown in Tables 2 (2000) and 3 (2010). The overall percentage of cited articles that were self-citations was 17.75 $\pm$ 11.31% ranging between 0 and 76.32%. Out of the 483 articles analysed, only 9 did not self-cite and 360 articles had a self-citation percentage of over 10% (i.e., at least 10% of cites were self-citation). The total number of self-citations per article was higher in 2010 (14.22 $\pm$ 10.40) than in 2000 (12.05 $\pm$ 9.15; Mann–Whitney U test, $T = 55548.5$, $df = 481$, $p = 0.005$), however the mean percentage of cited articles that were self-citations were not different between 2010 (17.08 $\pm$ 10.73%) and 2000 (18.27 $\pm$ 11.74%; Mann–Whitney U test, $T = 50156.5$, $df = 481$, $p = 0.451$) as a result of the greater number of citations per article in 2010. There were no significant differences between journals in terms of the percentage of self-citations (ANOVA; $F = 1.00_{9,463}$,

Table 2 Citation analysis of American Physiological Society journals 2000

Journal	Number of research articles	Mean ± SD; Median (minimum–maximum)					
		Number of authors	Number of references	% of self-citations	% of self citations first author	% of self citations last author	Maximum % of self cites for any author
AJP—Cell Physiology	22	4.3 ± 1.5	39.3 ± 9.6	16.7 ± 11.5	5.8 ± 8.2	14.7 ± 11.0	15.3 ± 10.9
		4.0 (2.0–7.0)	37.0 (23.0–56.0)	16.1 (0.0–36.7)	2.2 (0.0–26.9)	11.9 (0.0–36.7)	14.4 (0.0–36.7)
AJP—Endocrinology and Metabolism	20	4.2 ± 1.8	35.4 ± 9.4	21.3 ± 16.8	9.8 ± 10.6	14.1 ± 15.0	18.8 ± 15.2
		4.0 (2.0–7.0)	37.0 (22.0–53.0)	13.1 (2.7–59.3)	7.0 (0.0–40.0)	9.2 (0.0–59.3)	13.1 (2.7–59.3)
AJP—Gastrointestinal and Liver Physiology	21	4.8 ± 1.6	39.3 ± 10.4	19.5 ± 10.8	5.8 ± 4.6	17.1 ± 11.2	17.9 ± 10.4
		4.0 (2.0–8.0)	37.0 (20.0–61.0)	16.7 (4.9–39.3)	5.4 (0.0–16.7)	14.3 (0.0–36.7)	16.7 (4.9 ± 36.7)
AJP—Heart and Circulatory Physiology	32	4.2 ± 1.9	39.0 ± 12.9	17.3 ± 11.9	6.0 ± 6.4	14.1 ± 11.0	15.9 ± 10.9
		4.0 (2.0–8.0)	36 (12.0–72.0)	15.8 (0.0–52.0)	3.2 (0.0–21.1)	11.9 (0.0–48.0)	15.8 (0.0–48.0)
AJP—Lung Cellular and Molecular Physiology	27	5.1 ± 1.7	37.2 ± 8.6	20.5 ± 11.9	7.8 ± 8.8	15.7 ± 9.6	17.6 ± 9.6
		5.0 (2.0–7.0)	37.0 (22.0–67.0)	19.4 (5.3–48.4)	5.6 (0.0–36.7)	15.0 (1.5–36.7)	15.9 (4.4–36.7)
AJP—Regulatory, Integrative and Comparative Physiology	35	4.5 ± 2.1	34.9 ± 10.5	18.6 ± 10.6	7.7 ± 9.7	11.7 ± 10.0	16.3 ± 9.8
		4.0 (2.0–9.0)	33.0 (16.0–60.0)	17.8 (0.0–44.0)	4.2 (0.0–38.5)	10.5 (0.0–34.6)	15.8 (0.0–38.5)
AJP—Renal Physiology	16	4.9 ± 2.5	47.0 ± 23.5	20.1 ± 13.5	5.1 ± 4.7	14.4 ± 10.6	17.3 ± 13.7
		4.0 (2.0–9.0)	42.0 (27.0–126.0)	17.5 (4.0–60.0)	4.3 (0.0–13.3)	10.9 (0.8–31.4)	12.6 (3.2–56.7)
Physiological Genomics	4	6.0 ± 3.4	32.3 ± 8.3	20.7 ± 11.3	10.7 ± 5.6	13.7 ± 6.9	15.3 ± 6.3
		7.5 (1.0–8.0)	29.5 (26.0–44.0)	21.8 (7.4–31.8)	11.4 (4.6–15.6)	12.4 (22.7–7.4)	15.5 (7.4 ± 22.7)
Journal of Applied Physiology	39	4.5 ± 1.9	35.3 ± 10.2	17.7 ± 10.3	6.7 ± 8.0	12.1 ± 9.6	15.9 ± 9.1
		4.0 (1.0–11.0)	35.0 (18.0–58.0)	16.3 (2.2–40.0)	5.2 (0.0–40.0)	12.1 (0.0–38.1)	14.6 (2.2–40.0)
Journal of Neurophysiology	55	3.0 ± 1.3	52.5 ± 20.7	16.3 ± 11.3	8.2 ± 7.2	10.1 ± 11.1	15.0 ± 10.5
		3.0 (1.0–8.0)	52.0 (15.0–115.0)	15.8 (1.7–56.7)	6.8 (0.0–36.4)	6.7 (0.0–50.0)	13.8 (1.7 ± 50.0)
Average ± SD;		4.2 ± 1.9	40.6 ± 15.4	18.3 ± 11.7	7.2 ± 7.8	13.2 ± 10.9	16.3 ± 10.7
Median (minimum–maximum)		4.0 (1.0–11.0)	12.0 (38.0–126.0)	16.3 (0.0–60.0)	5.0 (0.0–40.0)	10.9 (0.0–59.3)	14.6 (0.0–59.3)

Table 3 Citation analysis of American Physiological Society journals 2010

Journal	Number of research articles	Mean ± SD; Median (minimum–maximum)					
		Number of authors	Number of references	% of self-citations	% of self citations first author	% of self citations last author	Maximum % of self cites for any author
AJP—Cell Physiology	19	5.4 ± 3.3	45.2 ± 16.8	16.4 ± 10.1	4.7 ± 5.3	12.6 ± 8.6	14.1 ± 8.5
		4.0 (2.0 –15.0)	43.0 (18.0–83.0)	15.8 (1.9–38.7)	2.6 (0.0–20)	12.5 (1.9–38.7	14.6 (1.9 ± 38.7)
AJP—Endocrinology and Metabolism	13	6.7 ± 2.1	49.5 ± 10.5	16.1 ± 8.4	3.8 ± 5.7	13.1 ± 8.5	13.6 ± 7.9
		6.0 (4.0–10.0)	46.0 (38.0–74.0)	17.4 (2.0–27.3)	1.9 (0.0–16.4)	10.4 (0.0–27.3)	10.9 (2.0–27.3)
AJP—Gastrointestinal and Liver Physiology	14	6.6 ± 2.1	43.4 ± 13.1	15.4 ± 8.0	5.3 ± 6.7	9.6 ± 5.2	12.1 ± 6.3
		6.0 (3.0–11.0)	40.5 (25.0–70.0)	8.0 (3.4–32.4)	2.7 (0.0–18.9)	10.7 (0.0–19.2)	11.7 (3.4–27.0)
AJP—Heart and Circulatory Physiology	30	5.4 ± 2.8	45.2 + 15.0	17.3 ± 10.4	7.0 ± 6.8	12.4 ± 11.6	15.5 ± 10.1
		5.5 (2.0–10.0)	45.0 (22.0–85.0)	16.6 (1.9–51.3)	4.6 (0.0–21.4)	10.0 (0.0–51.3)	14.1 (1.9–51.3)
AJP—Lung Cellular and Molecular Physiology	10	7.3 ± 4.4	52.8 ± 13.4	25.1 ± 20.1	9.7 ± 20.0	15.1 ± 16.0	20.2 ± 18.9
		6.0 (3.0–19.0)	55.0 (31.0–75.0)	19.0 (1.6–76.3)	2.5 (0.0–65.8)	10.9 (1.6–55.3)	13.0 (1.6–65.8)
AJP—Regulatory, Integrative and Comparative Physiology	26	5.4 ± 2.3	55.1 ± 17.4	16.8 ± 8.5	5.7 ± 5.8	9.9 ± 8.0	13.7 ± 7.5
		5.0 (2.0–12.0)	55.5 (18.0–97.0)	16.2 (0.0–33.3)	3.4 (0.0–17.7)	11.0 (0.0–33.3)	13.0 (0.0–33.3)
AJP—Renal Physiology	21	5.6 ± 2.9	39.8 ± 9.3	16.1 ± 9.5	5.9 ± 5.2	12.9 ± 10.7	15.2 ± 9.7
		4.0 (2.0–12.0)	37.0 (23.0–59.0)	13.7 (2.1–39.4)	5.6 (0.0–18.2)	12.5 (0.0–39.4)	12.8 (1.7–39.4)
Physiological Genomics	4	7.0 ± 2.2	55.0 ± 30.0	22.9 ± 5.0	0.3 ± 0.6	6.7 ± 8.7	17.9 ± 5.7
		6.5 (5.0–10.0)	55.0 (21.0–89.0)	22.6 (17.4–29.3)	0.0 (0.0–1.1)	3.7 (0.0–19.5)	18.7 (10.1–23.8)
Journal of Applied Physiology	23	5.6 ± 2.5	44.9 ± 14.0	15.9 ± 13.3	3.4 ± 4.3	10.1 ± 7.8	13.2 ± 10.7
		5.0 (2.0–10.0)	44.0 (27.0–81.0)	14.8 (0.0–48.4)	2.3 (0.0–16.7)	8.1 (0.0–31.3)	11.4 (0.0–48.4)
Journal of Neurophysiology	52	3.6 ± 1.6	58.8 ± 25.6	16.9 ± 10.1	4.6 ± 4.9	13.6 ± 10.4	15.1 ± 9.7
		3.0 (1.0–8.0)	57.5 (18.0–185.0)	15.5 (0.0–44.4)	3.2 (0.0–19.1)	12.7 (0.0–44.0)	13.6 (0.0–44.0)
Average ± SD;		5.3 ± 2.7	49.5 ± 18.9	17.1 ± 10.7	5.3 ± 6.9	12.1 ± 9.8	14.7 ± 9.7
Median (minimum–maximum)		5.0 (1.0–19.0)	47.5 (18.0–185.0)	16.0 (0.0–76.3)	3.1 (0.0–65.8)	11.2 (0.0–55.3)	13.0 (0.0–65.8)

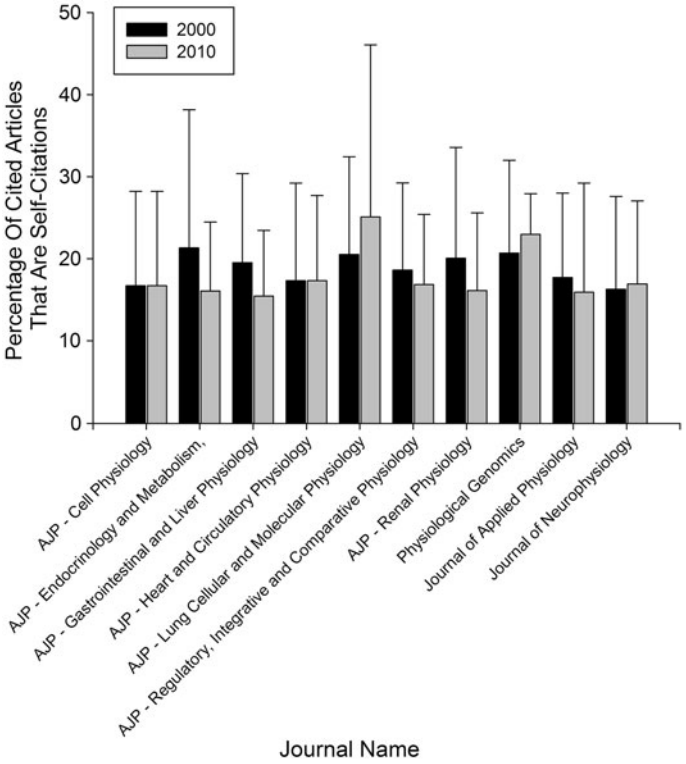

Fig. 2 The percentage of cited articles that are self-citations in American Physiological Society journals in 2000 and 2010. Data are mean ± standard deviation

$p = 0.436$), nor were there differences in the percentage of self-citation for any specific journal between 2000 and 2010 (ANOVA; $F = 0.538_{1,463}$, $p = 0.464$; Fig. 2).

Last authors (12.69 ± 10.44%) were significantly more likely to be self-cited than first authors (6.35 ± 7.50%; Mann–Whitney U test, $T = 185832.0$, $df = 964$, $p < 0.001$) and this trend was seen across both years of study and in all journals. In fact, last authors were cited at least as many times as first authors in every one of the 483 articles analysed. Last authors were the most self-cited author in 69.77% of articles analysed, and the first or last author was the most self-cited author in 100% of articles analysed.

There was no significant difference in the degree of self-citation between authors from different locations for either first (Kruskal–Wallis ANOVA on Ranks $H = 22.89$, $df = 22$, $p = 0.408$) or last authors (Kruskal–Wallis ANOVA on Ranks $H = 21.21$, $df = 22$, $p = 0.508$). When last authors were grouped by continent, last authors based in North America (13.48 ± 10.82%) self-cited the most. Asian based last authors (8.69 ± 6.69%) self-cited the least and the level of self-citation from Europe and Australia were similar (~10%). There were only two last authors based in South American and none from Africa.

Discussion

Bibliometric analysis of 483 articles from American Physiological Society journals from both 2000 and 2010 revealed a number of trends in citation and self-citation. For example,

the largest proportion of published articles originated in North American countries (Canada and the United States accounted for over two-thirds of published articles). It has previously been shown that the United States is the worlds most prolific country in terms of the volume of publications and citations (King 2004) and as we were investigating journals published by the American Physiological Society our finding was not surprising. Additionally, American Physiological Society journals have relatively high impact factors for journals in the field of "Physiology" (compared to many journals published in other countries) such that there is the incentive for authors from all countries to publish within these journals. Further, it has been shown that authors cite references from other researchers within their own country approximately 31% more often than would be expected by chance, even when self-citations are removed from analyses (Pasterkamp et al. 2007). This tendency would mean that authors from the United States would cite other authors from the United States more often than "foreign" authors, thus promoting a greater proportion of publications from the United States.

We also noted an increase in the number of authors and number of citations per article between the years 2000 and 2010. An increase in the mean number of authors per article has previously been noted in medical journals (Drenth 1998; Mussurakis 1993). Mussurakis (1993) showed a doubling in the number of authors per article in radiology journals between 1966 and 1991, while Drenth (1998) demonstrated an increase in authorship in the *British Medical Journal* from 3.21 ± 1.89 (SD) in 1975 to 4.46 ± 2.04 in 1995. We measured an increase in the number of authors per paper from 4.25 ± 1.90 (SD) in 2000 to 5.29 ± 2.70 in 2010. Reasons for this increase in author number may reflect a number of things. Firstly, there is significant pressure for researchers to publish their work (as evidenced by the degree of self-citation) such that a proportion of authors may be granted "gift-authorship". This is defined by Drenth (1998) as "granting of authorship to those who did not make any intellectual effort for the study". It is known that up to 26% of authors named on multi-author papers do not contribute significantly to the work (Shapiro et al. 1994), and it is common practice for supervisors or heads of department being gifted authorship with little or no contribution. Further, as time progresses, input from a greater number of researchers may be required in order to complete a publishable scientific study. Today, many published articles are multidisciplinary and thus require input (and authorship) from researchers from a variety of fields, thus increasing the number of authors per article.

Several previous publications have analysed the incidence of self-citation (of both authors and journals) in scientific or medical journals (Pasterkamp et al. 2007; Gami et al. 2004; Motamed et al. 2002; Fassoulaki et al. 2000; Miguel and Martí-Bonmatí 2002). These studies have generally focussed on one particular research area, and have identified that self-citation is common throughout a range of research fields. For example, Pasterkamp et al. (2007) found that self-citation accounted for 17.3% of all citations in a range of cardiovascular journals, while Miguel and Martí-Bonmatí (2002) found that self-citations accounted for 16.9% of all citations in 3 radiology journals. Falagas and Kavvidia (2006) performed an analysis of self-citation in 6 leading biomedical journals, including *Science* and *Nature* and found that 19% of all citations in original articles were self-citations. These rates of self-citation are remarkably similar to the 17.75% measured for American Physiological Society journals in this study, suggesting that self-citation is common across biomedical journals, and accounts for approximately 1 in 5 citations. As previously mentioned, self-citation can be motivated by a desire for self-promotion, egotism or due to the cumulative nature of scientific work (Aksnes 2003; Hyland 2003). This last hypothesis is supported by our (and others) finding that last authors are significantly more likely to be

self-cited than other authors. Self-citation can also serve necessary functions such as allowing authors to refer to previously established methodologies, or allowing authors to provide justification/support for future studies based on their previous publications (Gami et al. 2004). Additionally, in specialist fields (e.g., radiology; Mussurakis 1993), self-citation may be necessary simply because of a paucity of alternative literature.

The impacts of self-citation have been described in a number of studies (Engqvist and Frommon 2008; Foley and Della Sala 2010; Fowler and Aksnes 2007; Glänzel and Thijs 2004; Hyland 2003). These studies have shown that self-citation does benefit authors, with each additional self-citation increasing the number of citations from other authors by 3.65 after 10 years (Fowler and Aksnes 2007). This trend is obviously cumulative, with a greater number of self-citations resulting in more citations from other authors. Thus, self-citation by authors with fewer publications/citations and a small number of citations may make a large difference to their apparent academic prowess. Consequently, this raises the question as to what degree is self-citation a problem. It is known that citation rates are used for assessing the impact of individual authors, institutions and journals (Falagas and Kavvadia 2006), and as such self-citation will undermine the accuracy of indicators such as the *h* index (Engqvist and Frommon 2008; Vanclay 2007). Phelan (1999) argues that at the level of country or university, self-citation may not be as large a problem as at the level of the individual author. This is based on the idea that if rates of self-citation are relatively uniform across countries (as we have shown) and institutions, then each country/institution is skewed equally. It is at the level of the research group or individual, however, that self-citation rates are not uniform and, thus at this level self-citation can represent a problem (Phelan 1999). It has been suggested that self-citations be removed from indicators of scientific performance (Aksnes 2003; Fowler and Aksnes 2007; Glänzel and Thijs 2004; Phelan 1999), however this is no simple matter and raises a number of both procedural and ethical considerations. In particular, removal of "justified" last author self-citations would unfairly lower the bibliometric impact of their work. Consequently, removal of self-citations from performance indicators is an insufficient fix (Fowler and Aksnes 2007). The complexity of this situation suggests that perhaps a more "self-citation aware" attitude be taken by journal editors, and perhaps manuscript reviewers. If these people whom are already tasked with assessing the scientific merit of a submitted article also take time to assess the degree of self-citation on a case-by-case basis, unjustified self-citation could be avoided. Journal editors and reviewers are experts in their respective fields, and should be intimately familiar with relevant literature. Thus, it would be a relatively simple undertaking for these people to assess whether self-citations in submitted manuscripts are justified, or simply eigenlob.

In conclusion, we found that self-citation was relatively common, and occurred at a similar level across a range of American Physiological Society journals. The degree of self-citation by authors ($\sim$17%) was very similar to the degree of self-citation reported for other biomedical journals. We also noted a trend towards more authors and more citations per article between 2000 and 2010, however, there was no increase in the degree of self-citation over this time. As previously reported in other scientific fields, last authors were self-cited more than any other author. Author location did not strongly influence the degree of self-citation. This study provides support to the notion that self-citation represents a significant proportion of all citations in biomedical journals, and thus can artificially skew indicators of scientific performance. Unfortunately, there are no simple methods that allow the degree of self-citation to be taken into account when assessing an individuals' scientific performance unless a stronger emphasis is placed on the review process at the pre-publication level.

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