Do Blog Citations Correlate With a Higher Number of Future Citations? Research Blogs as a Potential Source for Alternative Metrics

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Journal-based citations are an important source of data for impact indices. However, the impact of journal articles extends beyond formal scholarly discourse. Measuring online scholarly impact calls for new indices, complementary to the older ones. This article examines a possible alternative metric source, blog posts aggregated at ResearchBlogging.org, which discuss peer-reviewed articles and provide full bibliographic references. Articles reviewed in these blogs therefore receive "blog citations." We hypothesized that articles receiving blog citations close to their publication time receive more journal citations later than the articles in the same journal published in the same year that did not receive such blog citations. Statistically significant evidence for articles published in 2009 and 2010 support this hypothesis for seven of 12 journals (58%) in 2009 and 13 of 19 journals (68%) in 2010. We suggest, based on these results, that blog citations can be used as an alternative metric source.

Introduction

Traditional scholarly impact metrics live in an ivory tower made of formal publications. The citations generated from peer-reviewed publications have been, for decades, the building blocks for impact metrics, which rely on the slow accumulation of citations from one peer-reviewed publication to another. However, the age of the web has given rise to new venues of discussion and dissemination of scholarly information. These highlight the limitations of traditional indices and the need for additional impact metrics in the bibliometric tool box to supplement the existing indices.

During the past few decades, the growing popularity of bibliometric indices has led to a thorough study of the citation process. The type of document and its subject, publishing venue, authors, and other characteristics all influence its citation impact in, statistically speaking, predictable ways.

The number of citations to a document has been known to be affected by its type. Looking at Norwegian articles from the years 1981–1996, Aksnes (2003) found that, although only 2% of the articles he studied were review articles, they formed 12% of the highly cited articles. Notes and proceeding papers, on the other hand, were less well represented among the highly cited than in the general article sample.

Citations are not equally distributed; in fact, their distribution is highly skewed (Seglen, 1992). Therefore, attributing the average number of journal citations to a single journal article can be misleading. A small number of highly cited articles greatly impacts average-based indices (e.g., the Journal Impact Factor).

Scientists do not exist in a vacuum, and neither do citations. Phillips, Kanter, Bednarczyk, and Tastad (1991) compared citations to *New England Journal of Medicine* (*NEJM*) articles covered by the *New York Times* with similar *NEJM* articles that were not covered by the *New York Times* and found the covered articles to have a citation advantage. It is possible that the advantage came from the *New York Times* staff's ability to pick better articles for coverage, but

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a 12-week *New York Times* strike in 1978 allowed the authors to put the hypothesis to the test by looking at articles selected during the strike. (The newspaper produced an "edition of record," which was not publicly distributed.) They found that articles covered by the *Times* received almost 73% more citations than control articles that appeared in the same *NEJM* issues and the same category but were not covered by the *Times* in the first year after publication, and they continued to receive more citations in the 10 years after their publication. This effect was not present for articles selected during the *Times* strike, providing evidence of the ability of the mass media to affect scholarly research dissemination.

As scholarly communication migrated to the web, so did citations. However, the meaning of *web citation* remained rather vague because the web is made of much more than formal research discourse, and citations can appear everywhere. Vaughan and Shaw (2003) were the first to investigate web citations to academic articles on a large scale but did not offer a clear theory-based definition of them. Based on Vaughan and Shaw's work, Bar-Ilan (2008) had broadly defined the term as "an appearance of the title of a publication within a webpage (not necessarily as a link)" (p. 22). A more vague definition was offered by Thelwall, Vaughan, and Björneborn (2005): "how often the journal articles were mentioned in web pages" (p. 101). Compared with the well-studied journal citations, web citations, especially in the social media, are still somewhat a mystery. If peer-reviewed journal citations are "frozen footprints" (Cronin, 1981, p. 16) and "signposts left behind after information has been utilized" (Smith, 1981, p. 85), what are web citations, inasmuch as the web can change?

Alternative Metrics

Altmetrics, short for alternative metrics, is a term to describe web-based metrics for the impact of scholarly material, with an emphasis on social media outlets as sources of data (Priem, Taraborelli, Groth, & Neylon, 2010). Microblogs (e.g., Twitter), reference managers, research blogs, postpublication peer review, and other resources have been suggested as possible alternative metrics sources.

Founded in 2006, Twitter is a popular microblogging service with more than 200 million active users and 400 million messages ("tweets") being sent each day (Wickre, 2013). Tweets are short messages up to 140 characters in length. Eysenbach (2011) found a correlation between the number of tweets about *Journal of Medical Internet Research* [*JMIR*] articles and future citation counts. A study of the correlation between tweets about arXiv repository preprints and Google Scholar Citations showed similar results (Shuai, Pepe, & Bollen, 2012). These findings show tweeting to be a promising altmetric source. However, the difficulty of archiving extremely large amounts of tweets and retrieving them may prove a challenge to researchers. Twitter does not provide freely full access to all of its tweets, but access can be obtained through a reseller for a price (Tornes, 2013). In addition, Twitter has donated tweets to the Library of Congress, which has archived tweets from the years 2006–2010 so far. However, a single search in the archive currently takes about 24 hours and requires a physical presence in the library's building (Library of Congress, 2013). Other than the difficulties described previously, the lack of effort required to produce a tweet may make tweet-based altmetrics an easy target of manipulation.

Looking at data from the commercial service altmetric.com and the Web of Science (WoS) database, Thelwall, Haustein, Larivière, and Sugimoto (2013) studied associations between journal citations and different altmetric indicators. Their sample included articles archived by the biomedical and life sciences database PubMed between July 2011 and January 1, 2013. Six of the eleven altmetrics sources that they studied (tweets, Facebook wall posts, research highlights, blog mentions, mainstream media mentions, and forum posts) had significant associations between higher altmetric scores and higher numbers of citations, suggesting that multiple different types of altmetrics may be valid and useful. F1000Prime (formerly Faculty of 1000; F1000 from here onward) is a commercial postpublication peer-review service. It offers reviews of published articles' scientific quality in the medical and life science by about 10,000 experts (F1000, 2012a), and more than 1,500 articles are recommended every month (F1000, 2012b). Several studies (e.g., Li & Thelwall, 2012; Mohammadi & Thelwall, 2013a; Waltman & Costas, 2013) have been conducted to study this platform and compare it with reference managers and with citations to study the dynamics of the reviewing process and the types of articles being reviewed.

Scholarly social bookmarking services such as Mendeley and CiteULike allow the storing and sharing of scholarly material. The number of users who saved an item by bookmarking it (called *readers* on Mendeley) is shown next to every item listed in those services. Users are also capable of tagging items with freely chosen key words.

The easily accessible, large numbers of readers in reference managers make for a promising altmetrics source. However, the lack of context makes it difficult to determine the underlying use made of a bookmarked article. The users might be called *readers* but it is possible that they have not read the item they bookmarked or that they have read it but did not make use of it. On the other hand, it could be that they use reference managers to easily access important articles over and again. Correlations between reader counts and citations have been studied in various settings: for *Science* and *Nature* articles (Li, Thelwall, & Giustini, 2012), for *JASIST* articles (Bar-Ilan, 2012a), for articles in the fields of the social sciences and the humanities (Mohammadi & Thelwall, 2013b), and for articles published by scientometricians (Bar-Ilan et al., 2012). These studies showed significant correlations of about 0.5 between Mendeley reader counts and citations. Although reader counts have their limitations, the broad coverage of reference managers,

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especially Mendeley, and their continuous growth can make them an important altmetric source.

Science and Research Blogs

Science blogs publish posts related to science and review scientific developments, and have become popular with a section of the scholarly community. Respected scholarly media outlets such as *National Geographic*, the *Nature* group, *Scientific American*, and the *PLoS* journals all have science blogging networks. A *Nature Medicine* editorial, discussing blogs and peer review, concluded that "Online science blogs are a valuable forum for commenting on published research, but their present importance lies in complementing rather than replacing the current system of peer review" ("Perfecting Peer Review?" 2011, pp. 1–2).

Kousha, Thelwall, and Rezaie (2010) have shown that it is possible, at least on a small scale, to calculate blog mentions for a set of published articles by using Google Blog Search. They concluded that, although blog citations were found to be far less common than academic citations, they could still be useful evidence of research impact on wider discussions, especially in the social sciences and humanities. Kousha et al. (2010) considered every mention of scholarly articles in blogs as citations, but we would differentiate between blog mentions and blog citations. Blog mentions are any sort of reference to scholarly material in blogs, whereas blog citations cite scholarly materials in structured, formal styles (e.g., APA, MLA) and appear in blog posts.

Unlike authors of peer-reviewed articles, bloggers are not obligated to reference their sources in a formal way. Despite this, Kjellberg (2010) found that scientist bloggers would like to employ formal referencing norms in their blogs.

> A recurring topic in the interviews has to do with the fact that the researchers want to use references and point to their sources in the blog, in a similar way to how they do in regular communication within the scholarly environment. (Paragraph 21)

Further evidence of the diffusion of norms from formal academic citing to blogs is the aggregator ResearchBlogging.org (RB). ResearchBlogging.org (2008) aggregates blog posts referring specifically to peer-reviewed research. It is a self-selecting aggregator that allows bloggers to refer to peer-reviewed research in an academic citation format. Bloggers discussing peer-reviewed research can register with the aggregator and after they mark relevant posts in their blog, these posts appear on the aggregator site, giving one-stop access to a variety of research reviews from different authors. The site's human editors ensure that blogs submitted to the aggregator follow its guidelines and are of appropriate quality. RB already has an altmetric role; it currently serves as one of the article level metrics (ALM) displayed for each article in the journal *PLoS ONE* (n.d.). By the end of 2011, RB had more than 1,230 active blogs and about 27,000 posts.

Groth and Gurney (2010) were the first to conduct an RB study and focused on posts tagged "chemistry." Those posts referred to literature that was mostly up to date and published by top-tier journals: More than 70% of the cited articles were from the top 20 journals in the field of chemistry, and 21% were from the 60 top publications across all disciplines. Other studies (Fausto et al., 2012; Shema, Bar-Ilan, & Thelwall, 2012) have indicated that the most often cited publications in blog posts (in no specific order) were the multidisciplinary journals *Science*, *Nature*, *Proceedings of the National Academy of Sciences of the United States of America* (*PNAS*), and the open-access (OA) journal *PLoS ONE*. The life sciences are by far the most popular in RB, with 36% of the total. Other popular categories were health sciences (15%) and psychology (13%). Only 11.7% of the citations came from OA journals (Fausto et al., 2012).

Science bloggers link to various sources, including other blogs, mainstream media, and scholarly material. A survey of SciLogs bloggers (a German blogging platform) showed that they were equally likely to have a post topic brought to their attention by the mainstream media as by scholarly publications (Puschmann & Mahrt, 2012). Looking at bloggers affiliated with research institutes from Scienceblogs.com and Scienceblogs.de, Peters, Beutelspacher, Maghferat, and Terliesner (2012) found that bloggers often link to their own blogs or other blogs in their platform, to social media sites, and to major news sites such as *Spiegel* or the *New York Times*.

Given a bloggers' use of formal citation norms and scholarly sources, a connection to the research community is not unexpected. Shema et al. (2012) found that a majority (59%) of science bloggers were part of the academic community in some capacity. Puschmann and Mahrt (2012) found that 43% of the SciLogs bloggers were employed in the academy. In both studies, the bloggers were highly educated, with 32% of the RB bloggers and 45% of the SciLogs bloggers having earned a PhD. Zivkovic, the former editor of *PLoS* blogs and current editor of *Scientific American* blogs, estimated that "[Blogs are] written by graduate students, postdocs and young faculty, a few by undergraduates and tenured faculty, several by science teachers, and just a few by professional journalists" (Bonetta, 2007, p. 443).

We hypothesize that, because many of the bloggers are or were part of the academic community, they would be capable of recognizing articles that will appeal to its members. Therefore, we examined whether articles that were published in peer-reviewed journals and were reviewed in blogs aggregated by ResearchBlogging.org soon after their publication were more highly cited than articles published in the same year and in the same journal but that were not reviewed in the year of their publication in blogs aggregated by ResearchBlogging.org.

Data and Methods

ResearchBlogging.org publishes an extended snippet of all the posts that it aggregates. An example of such a snippet is given in Figure 1. All the snippets of posts published during 2009 and 2010 were downloaded using the

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Quasicrystals… now all natural!

Physics

by gg in Skulls in the Stars

September 9, 2009
11:56 AM
874 views

This result came out a few months ago, and I've been looking for the time to write about it ever since: in a paper published in the June 5 issue of Science, scientists reported the discovery of the first natural quasicrystal!
Of course, in order to get excited about this result, one needs to know what [...]... Read more »

Bindi, L., Steinhardt, P., Yao, N., & Lu, P. (2009) Natural Quasicrystals. Science, 324 (5932), 1306-1309. DOI: 10.1126/science.1170827

FIG. 1. Snippet of a blog post. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

TABLE 1. Journals with more than 20 articles published in 2009 and reviewed in 2009 in blog posts aggregated by ResearchBlogging.org by decreasing number of reviewed articles in blogs.

Journal	No. of articles published by the journal in 2009	No. of articles reviewed by bloggers in 2009	Articles reviewed by bloggers in 2009 (% of the number of overall articles published by each journal)
PLoS One	4,403	193	4.4
PNAS	3,765	166	4.4
Science	897	161	17.9
Nature	866	119	13.7
Psychological Science	234	49	20.9
Journal of Neuroscience	1,542	40	2.6
Journal of the American Chemical Society	3,332	34	1.02
Current Biology	357	28	7.8
PLoS Biology	195	26	13.3
New England Journal of Medicine	352	26	7.4
Pediatrics	752	23	3.1
Nature Neuroscience	208	22	10.6

DownThemAll add-on on to Firefox (http://www.downthemall.net/). Altogether 4,878 snippets from 2009 and 7,777 from 2010 were downloaded. We developed software to extract the following fields automatically from these snippets: date of publication of the post, number of views of the post, title and URL of the blog post, name of the blogger and of the blog, and for each citation that appeared in the blog post (there are posts that contain several blog citations), author, title, year, source, and DOI or URL of the specific publication. Altogether 6,927 and 11,500 blog citations were identified by this process for 2009 and 2010, respectively.

We were interested in blog citations that appeared soon after the publication of an article, so we considered only blog posts reviewing articles published in 2009 and 2010 (4,013 and 6,116 items, respectively). We considered only blog posts from the year of publication of the article (e.g., a 2009 blog post could only discuss a 2009 article). Next, we limited the sample to only journals with 20 or more articles published in the journal and reviewed in ResearchBlogging.org during 2009 or 2010. The 20-article threshold was a compromise between the need to obtain statistically reliable results and the need to include as many journals as possible in the analysis. Editorials, letters, and other document types were excluded, leaving only articles, reviews, and proceedings papers to be considered. Articles that appeared numerous times in the sample were taken into consideration only once. A list of the journals appears in Tables 1 and 2. Details of the articles published in these journals during 2009 and 2010 and the citations they received in 2009, 2010, 2011, and 2012 were retrieved from the WoS. The WoS database records articles according to their official publication date rather than the online publication date. Therefore, we used the official date, even if an online version was published before it.

Three journals (*Current Biology*, *Journal of the American Chemical Society*, and *Nature Neuroscience*) fell below the 20-article threshold in 2010 and were removed from the list. Ten others journals passed the threshold and were added to the 2010 list.

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TABLE 2. Journals with more than 20 articles published in 2010 and reviewed in 2010 in blog posts aggregated by ResearchBlogging.org by decreasing number of reviewed articles in blogs.

Journal	No. of articles published by the journal in 2010	No. of articles reviewed by bloggers in 2010	Articles reviewed by bloggers in 2010 (% of the number of overall articles published by each journal)
PLoS One	6,723	288	4.3
PNAS	3,765	243	6.5
Nature	862	196	22.7
Science	861	171	19.9
Psychological Science	284	71	25.0
Journal of Neuroscience	1,662	67	4.0
PLoS Biology	214	40	18.7
New England Journal of Medicine	345	38	31
Physical Review Letters	3,107	37	1.2
JAMA	232	32	13.8
Proceedings of the Royal Society B Biological Sciences	452	27	6.0
Conservation Biology	171	26	15.2
Ecological Applications	177	24	13.6
Lancet	271	24	8.9
Biological Conservation	315	23	7.3
Cell	320	23	7.2
Pediatrics	702	23	3.3
PLoS Computational Biology	406	21	5.2
Biology Letters	216	20	9.3

TABLE 3. Number of sample articles below and above each journal's median for 2009 and 2010.

	2009–2011	2010–2012
Above median	507	823
Below median	380	571

TABLE 4. Median number of citations received by the reviewed and the nonreviewed articles in 2009.

Journal	Median no. of citations received during 2009–2011 for 2009 articles reviewed in RB blogs in 2009	Median no. of citations received during 2009–2011 for 2009 articles not reviewed in RB blogs in 2009
PLoS One	8	6
PNAS	20	16
Science	41	40
Nature	57	49
Psychological Science	8	9
Journal of Neuroscience	22	12
Journal of the American Chemical Society	19	14
Current Biology	13.5	15
PLoS Biology	18.5	17
New England Journal of Medicine	172	56
Pediatrics	13	7
Nature Neuroscience	32.5	24

The results from Tables 1 and 2 validate those of earlier studies regarding the most popular journals (*PLoS ONE*, *PNAS*, *Science*, and *Nature*). In addition, they show bloggers' preferences for the biological and medical disciplines, with eight of the 12 journals (67%) in 2009 and 14 of 19 journals (74%) in 2010 belonging to those fields

Results

This section presents findings separately for the years 2009 and 2010. First, we show results for one-sample binomial tests (Table 3) on the aggregated results of all the journals from Tables 1 and 2. Then, the results are broken down, and the medians for every journal's sample group are shown in comparison with the medians of articles that were not covered by the bloggers (Tables 4, 5). Results of Mann-Whitney tests are presented for each journal (Tables 6, 7). Next, we show the number of reviews in each journal in comparison with the number of reviews covered by bloggers (Table 8). Finally, we present a case study of the overlapping between the *NEJM* articles covered by bloggers and those reported by the media.

One-Sample Binomial Test

The article population medians were calculated separately for each journal for the years 2009 and 2010 (data not shown). We ran a nonparametric, one-sample binomial test to find if the aggregated citation categories below and above the journals' medians had different probabilities than the expected .5 (Table 3). The null hypothesis, that the

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TABLE 5. Median number of citations received by the reviewed and the nonreviewed articles in 2010.

Journal	Median no. of citations received during 2010–2012 for 2010 articles reviewed in RB blogs in 2010	Median no. of citations received during 2010–2012 for 2010 articles not reviewed in RB blogs in 2010
PLoS One	7	5
PNAS	23	15
Nature	60.5	49
Science	47.5	40.5
Psychological Science	5	7
Journal of Neuroscience	17	12
PLoS Biology	23.5	15
New England Journal of Medicine	138	51
Physical Review Letters	19	11
JAMA	38.5	36
Proceedings of the Royal Society B Biological Sciences	8	8
Conservation Biology	7	6
Ecological Applications	10	6
Lancet	99	50
Biological Conservation	7	6
Cell	77	43
Pediatrics	14	6
PLoS Computational Biology	6	7
Biology Letters	8.5	6

TABLE 6. Results of the Mann-Whitney tests, 2009.

Journal	*p* Values for the citation period 2009–2011
PLoS One	.002**
PNAS	.000**
Science	.975
Nature	.044*
Psychological Science	.833
Journal of Neuroscience	.000**
Journal of the American Chemical Society	.059
Current Biology	.253
PLoS Biology	.988
New England Journal of Medicine	.000**
Pediatrics	.004**
Nature Neuroscience	.003**

*$p < .05$; **$p < .01$.

categories occur with probability of .5, was rejected for 2009 and 2010 ($p < .001$). Hence, we have statistical evidence that citations attracted by blogged articles tend to be above the median for the journal in which they are published.

TABLE 7. Results of the Mann-Whitney tests, 2010.

Journal	*p* Values for the citation period 2010–2012
PLoS One	.000**
PNAS	.000**
Nature	.001**
Science	.040*
Psychological Science	.468
Journal of Neuroscience	.001**
PLoS Biology	.001**
New England Journal of Medicine	.000**
Physical Review Letters	.004**
JAMA	.742
Proceedings of the Royal Society B Biological Sciences	.674
Conservation Biology	.924
Ecological Applications	.027*
Lancet	.006**
Biological Conservation	.206
Cell	.006**
Pediatrics	.000**
PLoS Computational Biology	.603
Biology Letters	.042*

*$p < .05$; **$p < .01$.

Median Differences

It is well known that citation distributions are highly skewed (Seglen, 1992), so it is appropriate to consider medians instead of averages (Bar-Ilan, 2012b). Most of the journals in the sample belong to the life sciences, for which a 2- or 3-year citation window is considered adequate, because of the fast ageing of most journals and topics in the area (Glänzel & Schoepflin, 1995). In light of those past findings, we summed for each 2009 article the number of citations that it received during 2009, 2010, and 2011 (Table 4).

We see that the medians are higher for the articles that received blog citations except for the journals *Psychological Science* and *PLOS Biology* (Table 4). The most striking difference is for *NEJM*; the median number of citation received by articles that received early blog citations is more than three times the median number of citation received by the articles that were not reviewed in 2009 in blog posts aggregated by ResearchBlogging.org.

Other than for the journals *Psychological Science* and *PLOS Computational Biology*, all the medians of reviewed article groups are either equal or higher than those of the articles that were not reviewed by the bloggers (Table 5). Tables 4 and 5 show that, for most journals, the median numbers of citations of articles covered in blogs is higher than those of articles that were not covered in them. However, we could not tell by medians alone whether the blogged articles had a statistically significant citation advantage over those that were not. To study this at the level of journals, we conducted a series of nonparametric Mann-Whitney tests.

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TABLE 8. Number of reviews published in sample journals and number of reviews from sample journals covered by bloggers in 2009 and 2010.

Journal	No. of reviews published by the journal in 2009	No. of reviews covered by bloggers in 2009	No. of reviews published by the journal in 2010	No. of reviews covered by bloggers in 2010
PLoS One	9	0	32	2
PNAS	6	0	5	1
Nature	66	2	37	3
Science	54	4	61	8
Psychological Science	0	0	0	0
Journal of Neuroscience	37	2	6	0
PLoS Biology	0	0	0	0
New England Journal of Medicine	33	1	38	2
Physical Review Letters	–	–	0	0
JAMA	–	–	18	3
Proceedings of the Royal Society B Biological Sciences	–	–	21	1
Conservation Biology	–	–	8	0
Ecological Applications	–	–	0	0
Lancet	–	–	27	1
Biological Conservation	0	0	20	0
Cell	–	–	34	0
Pediatrics	38	0	35	1
PLoS Computational Biology	1	1	1	1
Biology Letters	–	–	0	0
Nature Neuroscience	5	1	–	–
Journal of the American Chemical Society	128	1	–	–
Current Biology	30	0	–	–

Mann-Whitney Tests

Table 6 shows the *p* values of the Mann-Whitney tests for differences between the blogged and nonblogged groups from 2009 for the citation periods 2009–2011. For seven of the 12 journals (58%) the differences are significant at $p < .05$ (for six journals the differences are significant at $p < .01$). The results for the *Journal of the American Chemical Society* are at the edge of significance.

Table 7 shows the results of the Mann-Whitney tests ($p < .05$) for each journal from the year 2010 for the citation periods of 2010–2012. In 2010, 13 of 19 journals (68%) had significant results for the citation periods studied (for 10 journals the results were significant at $p < .01$).

To be sure that blog citations in the year of publication could predict future citation, we repeated the analysis for 2009 with a 2010–2011 citation window and for 2010 with a 2011–2012 citation window (data not shown). There was no change in the statistical significance of any of the findings, showing that the bloggers' advantage, when it exists, comes not from articles that were already well-cited in the year of their publication but from future citations about which the bloggers would be unlikely to know.

Reviews

In light of review articles' overrepresentation among highly cited articles, we decided to test whether the bloggers tend to over- or undercover review articles from journals and whether review articles are connected with citation advantage. We searched each journal's sample for review articles from the same journal and year. Table 8 shows the overall number of articles classified as reviews in WoS published by a journal in 2009 or 2010 and the number of review articles covered by bloggers each year for the journal. We have not found evidence for over- or underuse of review articles in the samples, but their small size does not allow us to test for statistical significance.

Case Study: NEJM

NEJM is a prestigious medical journal (number one in the WoS category Medicine, general and internal) and is one of the leading peer-reviewed journals upon which science reporters rely (Conrad, 1999). We saw earlier that there are especially large differences between the samples' citation medians and other articles' citation medians for *NEJM* (Tables 4, 5). Given the differences and the citation "boost" that *NEJM* articles receive when covered by the *New York Times* (Phillips et al., 1991), as well as bloggers linking to the *New York Times* (Peters et al., 2012), we decided to conduct a pilot study using the *NEJM* articles from the 2009 and 2010 samples. We "translated" first the medical terms to everyday language (e.g., sildenafil equals Viagra), then searched the *Times* web site and the news agency Reuters' web site for stories covering the research published by *NEJM*. Twenty-one of 26 articles in 2009 (81%) and 20 of 38 articles in 2010 (53%) were covered by Reuters and/or the *Times*. Some articles were covered by more than one post, some posts covered more than one journal article, and some news articles covered more than one journal

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TABLE 9. Time differences between blog posts and news articles reporting *NEJM* articles for 2009 and 2010.

Time difference	2009	2010
1 week or less	10	9
1–2 weeks	3	2
2–4 weeks	4	4
More than 1 month	1	2
More than 2 months	1	5
Other	2	3

article. In the case of an article covered by both the *Times* and Reuters, we calculated the date differences using the date of the first published news article. Unless otherwise specified, the differences favor the news articles in the sense that they occurred earlier (Table 9). In 2009, the Other category includes two studies that were covered by the media months before the *NEJM* articles were published (by press releases and so forth). In 2010, two of the three articles in the Other category were published by the bloggers before they were reported on by either Reuters or the *Times*, and one study was covered by the media by press release rather than by its *NEJM* article.

Although many blog posts were published shortly after the news articles reporting the *NEJM* article they cover, some had gaps between the news article and the blog post publication. One reason could be that some bloggers are slow to catch up with current events. Unlike professional news reporters, bloggers are usually not paid and are not pressured to be the first reporting exciting news. Another reason could be that, although the bloggers use relatively current research in their posts, they use their blogs not as an alternative for traditional news venues but as platforms for their own agenda.

We have not searched other media outlets, but presumably some of them reported articles that were covered by the bloggers but were not reported either by Reuters or the *Times*, so the actual coverage percentage could be even higher. We cannot tell whether the bloggers and the mass media are affected by one another, but the results show that in many cases the mass media and the bloggers have similar preferences.

Limitations

The sample time span is one of the study's main limitations. RB has been active only since 2008, and, because of the slow accumulation of journal citations, we were able to use only articles from 2009–2010 because for them the citation window was sufficiently long. The year-long time frame for each sample meant, in theory, that the bloggers could have had some time to observe an article's popularity in the research community and cover it accordingly later in the same year.

The characteristics of RB were a source for some additional limitations. Being a self-selecting aggregator limited the sample to bloggers who chose to aggregate with it. The aggregator is focused on English-written blogs and is oriented toward certain disciplines and the biological and medical sciences in particular. These limitations have much in common with the study's source of journal citations, WoS. The WoS database coverage focuses on English-language peer-reviewed journals in the science, life science, and medicine fields. Its coverage is not as robust in the social sciences and the humanities, which often publish monographs and books rather than periodicals. Between the limitations of RB and WoS, the results might not be generalizable to all research blogs and scholarly disciplines.

Discussion and Conclusions

We described a potential source of alternative metrics, the research blog, using 2009 and 2010 data from the ResearchBlogging.org aggregator. We showed that the bloggers tend to prefer articles that turn out to be cited more often than other articles from the same year and journal. In a one-sample binomial test, the overall proportion of blogged articles above each journal's population median was significantly higher than the expected probability of .5 in the two citation periods calculated for 2009 and 2010.

At the journal level, seven of 12 journals in 2009 (58%) and 13 of 19 journals (68%) in 2010 had statistically significant results in terms of blogged articles attracting more citations. The higher number of significant results in 2010 might be due to the increasing number of blog posts and therefore articles in 2010 in comparison with 2009 (the "wisdom of crowds"). The results show that for some, but not all, journal articles blogged in RB tend subsequently to receive more citations than other articles from the same journal. There are many possible reasons for the cases of significant differences: Bloggers pick better articles to write about, and these attract more citations; bloggers sometimes write about articles that they use in their research and perhaps have already decided to cite when they blog about them; bloggers pick articles that are not necessarily better but are more interesting and are read more often and hence cited more often because of their interest; publicity from the mass media and/or blog post generates awareness of an article that leads to more citations. Whatever the reasons, it seems that, on balance, RB bloggers tend to pick articles that go on to become more highly cited than average. We note that most of the nonsignificant results came from the smaller journal samples. Had we chosen a higher threshold, for example, 50 articles, only two of the 10 journals meeting this criterion in both years would have had nonsignificant results. The results' statistical significance remained identical for citation windows that did not include the year of publication (2010–2011 for 2009 and 2011–2012 for 2010), emphasizing that the bloggers tend to choose articles that will be cited more often in later years.

The results validate those of Thelwall et al. (2013) regarding blogs and their association with citations for an unknown type of blog and without estimating an effect size.

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Our study goes further than Thelwall et al.'s by associating blog coverage with future citations, estimating the effect size (the difference in median citations for blogged and nonblogged research) and also covering a precisely defined sample of blogs. This study offers particular insights about research blogs in which the bloggers use formal citation style. Thelwall et al.'s study of blogs included only articles mentioned in blogs, and the number of times the article was mentioned in blogs was crucial in the analysis. They compared each article to the two published nearest its publication date. Here, on the other hand, we make comparisons between articles mentioned by blogs near their publication, irrespective of the number of times that they are mentioned in the blogs, and articles in the same journal and the same publication year that were not picked up by bloggers. The study shows the differences between all the RB blog-covered articles and those not covered in the relevant years and journals. Among the document types that we included in the sample, review articles were the type known to gather the most citations. However, our hypothesis that the bloggers' citing advantage might be due to greater use of review articles has not been proved. No evidence has been found of a connection between number of review articles in the sample in relation to the journals' population and a citation advantage or disadvantage.

Blog citations are worth pursuing as an altmetrics source, in part because of the effort put into them. Blog posts covering scholarly research that are written by humans and have real content (rather than advertisement or spam) take a great deal more time and thought than microblogging, bookmarking, or downloading, even if the latter activities are not automated. The content of posts gives blog citations context, which is lacking in some of the other altmetrics sources. In conclusion, the bloggers showed themselves capable of choosing articles that, as a group, will be cited more often than other articles in the same journal. Further research into the citing bloggers' motivations will allow a better understanding of their citations' functions and impact.

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