

How is Research Blogged? A Content Analysis Approach

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Abstract

Blogs that cite academic articles have emerged as a potential source for alternative impact metrics for the visibility of the blogged articles. Nevertheless, in order to more fully evaluate the value of blog citations, it is necessary to investigate whether research blogs focus on particular types of articles or give new perspectives into scientific discourse. Thus, we studied the characteristics of peer-reviewed references in blogs and the typical content of blog posts to get insights into the bloggers' motivations. The sample consisted of 391 blog posts from 2010-2012 in Researchblogging.org's Health category. The bloggers mostly cited recent research articles or reviews from top multidisciplinary and general medical journals. Using content analysis methods, we created a general classification scheme for blog post content with ten major topic categories, each with several subcategories. The results suggest that health research bloggers rarely self-cite and the vast majority of their blog posts (90%) include a general discussion of the issue covered in the article, with over a quarter providing health-related advice based on the article(s) covered. These factors suggest a genuine attempt to engage with a wider non-academic audience. Nevertheless, almost 30% of the posts included some criticism of the issues being discussed. Given that explicit criticism is rare in academic articles, this suggests that blogs are a more natural home for this important scientific activity.

Introduction

Peer-reviewed journal-based citations are the basis of today's bibliometric indicators. They are used as a proxy for the impact of scholarly works and are "*the most common means of bestowing credit and recognition in science*" (Cronin, 1984, p. 2 ¶ 3). In his early work about citation norms Kaplan (1965) regarded citation practices as "*in large part a social device for coping with problems of property rights and priority claims*" (p. 181, ¶ 3). Gilbert (1977) argued that by citing influential works, researchers add authority and persuasive power to their own works. The importance of citations in science evaluation and their ambiguity have made the motivations behind them a popular research subject.

The rise of the Web and online scholarly discourse has brought into question the motivations behind online citations to scholarly material. Those seeking to understand scholarly discourse today should take into account the use of peer-reviewed material in informal settings. Specialized message boards, e-mail lists, social networks, and blogs all host lively discussions regarding research. If we hope to estimate better the impact of scholarly works then we should pay careful attention to these informal discussions. The current study aims to understand the motivations behind blog posts citing peer-reviewed research.

Motivations behind blog posts citing peer reviewed research have not been studied before, but investigations of citation motivations provide a starting point. We provide a short review of a selection of such studies (for reviews see, among others, Cronin, 1984; Liu, 1993; Bornman & Daniel, 2008). According to Small (1982), studies of citation contexts have either classified references by function type or by the semantic content of the referring passage, although he noted that the two approaches are not mutually exclusive.

Citation motivations

Moravcsik and Murugesan (1975) conducted an early study of references from high energy physics journals, classifying them according to their function. References could have one of the two characteristics in each category or neither.

1. Conceptual/operational.
2. Organic/perfunctory
3. Evolutionary/juxtapositional
4. Confirmative/negational

A reference was classified as conceptual if the referring article used an idea or a theory from the cited article, and as operational if the article was cited because of a physical technique or a tool use by the citing article. Organic references were those made to articles which were essential to the referring article, while perfunctory references were not necessary for the understanding of the referring article. An evolutionary reference was one the citing article was built upon, while the juxtapositional reference was an alternative to the citing article. Confirmative references were those that the citing article's authors thought were correct with whereas negational ones were claimed by them to be incorrect. Only about 14% of the references were negational. A large percentage of the references were perfunctory (41%).

Chubin and Moitra (1975) classified references from high energy physics letters and articles. In their adaptation of Moravcsik and Murugesan's typology, references were classified into one out of six categories. Their starting point was the determination of a reference as affirmative or negational. Unlike Moravcsik and Murugesan, they divided

negational references into partial and total. A partial negative reference suggested that an article is wrong in part and offered a correction, while a total negative reference considered the cited article to be “*completely wrong and offer[ing] an independent interpretation or solution*” (p. 427). Affirmative references were classified as either essential or supplementary. The essential references were classified as basic or subsidiary and the supplementary ones as additional and perfunctory. Their percentage of perfunctory references was considerably lower (20%) and only about 5% of the references were partly negational (none were totally negational). In his review of reference motivation studies, Small (1982) speculated that the different results were due to differences in the classification schemes.

Cole and Cole (1971) offered a possible explanation for the low rate of negational references. They argued that researchers ignore works that they consider to be of low quality rather than criticizing them. The few works that receive criticism are those that researchers deem significant enough to take seriously. MacRoberts and MacRoberts (1984), on the other hand, wrote about “the art of dissembling”; ways researchers avoid direct criticism of their colleagues’ works. They noted uses of praise that they considered to be insincere and attributions of theories to outsiders rather than to prominent in-field researchers in order to avoid confrontation, as well as the use of perfunctory references. Brooks (1986) conducted a series of interviews with scholars from various disciplines. He found that about 70% of their references had multiple motivations. Harwood’s (2009) interviews regarding informants’ reference behavior found that they genuinely wanted to praise the strengths of works, even when they also criticized their weaknesses.

Unfortunately, citation classification schemes have limitations. White (2004) noted that reuse of classification schemes was problematic because of individual differences between disciplines. “*In truth,*” he wrote, “*the citation classification schemes are all idiosyncratic and hard to code [...]*” (p. 100, ¶1). Cronin’s conclusion (1984, p. 49, ¶2) regarding reference classification efforts was that “*None of the approaches mentioned is, or could have been, capable of providing us with privileged insights into the cognitive processes employed by citing authors.*”

Publication types and literature ageing

One of the current study’s aims is the characterization of blog citations in relation to publication type and age. From research into peer-reviewed journal citations we know that a publication’s characteristics can influence its impact, as represented by citations. In Aksnes’ study (2003) of Norwegian research, 84% of all publications were research articles, 9% were proceedings, notes 5% and reviews 2%. However, the distribution of highly cited publications was different, with research articles (81%), notes (3%) and proceedings (4%) less represented among the highly cited than their rate in the population and reviews (12%) being far more prominent in comparison with the population.

Elite multidisciplinary journals and medical journals tend to publish many editorials, letters, notes, book reviews and other types of short publications. Moed (2005) noted, for example, that in 2002 the *Lancet*, an elite medical journal, published 1,544 articles and reviews and 4,899 other documents.

In Glänzel and Schoepflin's study of literature ageing (1999), they found that references in immunology and research medicine had the lowest average age of all the science areas analysed. Moed (2005) showed that in biochemistry and molecular biology one- or two-year old articles are referred to, on average, 8.4 times per article. In the slow-paced mathematics discipline the average is 1.6 one or two year old references per article. Differences in citation rates may reflect differing citation norms. For example, there may be less perfunctory references in mathematics, or differing research speeds, with older articles being perhaps more likely to be irrelevant in biochemistry and molecular biology than in mathematics.

Classifying Web citations

The migration of much scholarly communication to the Web has highlighted the uses of scholarly material online. The term "Web citation" was first introduced by Vaughan and Shaw in a study of articles from library and information science journals (2003). Based on Vaughan and Shaw's study, Bar-Ilan (2008) defined Web citation as "*roughly an appearance of the title of a publication within a webpage (not necessarily as a link)*" (p. 22, section 8.5).

Vaughan and Shaw's study classified Web citations into seven categories: journal (listing of the work in the publisher's site), author (when the authors or someone connected to them lists the work), service (listing by bibliographic and current awareness services, e.g., the DBLP bibliography), class (a course reading list/bibliography), paper (cited in a paper posted online), conference (announcement of a conference, its description/summary or a report concerning it) and other (anything else).

Vaughan and Shaw's follow-up study (2005) used their 2003 scheme to classify journal articles from four fields. They merged the seven categories into three broader ones: research impact (e.g., in a scholarly article), other intellectual impact (e.g., course reading) and perfunctory (non-intellectual, e.g., an article listed in a bibliography site).

Jepsen, Seiden, Ingwersen, Björneborn and Borlund (2004) classified content from URLs containing specific terms related to plant biology into six categories: Scientific, with research-related content (e.g., research articles, preprints); scientifically related (e.g., researchers' CVs); teaching (e.g., textbooks, tutorials, student papers); low grade, which was material that did not belong with the previous groups, but was related to the searched topic (e.g., commercial material); noise, which consisted of material that did not fit any of the previous categories; and unavailable, the URLs that could not be reached.

Kousha and Thelwall (2007) sampled Web citations to open-access journals in four fields (biology, physics, chemistry, and computing). Similarly to previous studies, they categorized Web citations into formal scholarly impact (e.g., conference proceedings) and informal scholarly impact (e.g., reading lists). Their other categories were self-publicity (e.g., CVs), general navigational (e.g., tables of contents) and subject-specific navigational (e.g., subject-specific bibliographies) which included items that Jepsen et al. and Vaughan and Shaw saw as other intellectual impact or scientifically related. Naturally, they also had an “other” category.

Kousha and Thelwall (2007) concluded that *“the web provides access to a new and different type of citation information, one that may therefore enable us to measure different aspects of research, and the research process in particular, but in order to obtain good information the different types should be separated”*(abstract). We suggest that some of the intellectual impact of Web citations comes into play through research blogs.

Research blogging

Research blogs have proliferated in recent years, with respected media outlets (e.g., Nature, Wired, PLOS, The Guardian) maintaining their own research blogging networks. Some prominent scholars, such as the economics Nobel laureate Paul Krugman and mathematics Fields Medal laureates Timothy Gowers and Terence Tao, also run popular blogs.

Wilson and Starkweather (2013) recruited about 450 academic geographers (graduate students and PhDs employed as academic geographers at that time) for a study of web presences, using professional geography e-mail lists. They found that 20% of their respondents visited blogging and/or microblogging platforms at least daily. Gruzd and Goertzen (2013) surveyed the Web habits of over 300 researchers recruited by invitation through listservs from three associations: the American Society for Information Science and Technology (ASIS&T), the Association of Internet Researchers (AoIR), and the International Network for Social Network Analysis (INSNA). Reading and commenting in blogs were the second most frequent social media activities, but researchers rarely maintained their own blogs. However, both studies were based on online, non-random surveys, and may well be biased in favor of researchers that are particularly active online.

The motivations behind research blogging have been the subject of several surveys. In Kovic, Lulic and Brumini’s survey of medical bloggers (2008), the respondents’ main motivations were the desire to influence their audiences and to share their skills and practical knowledge. Their intended audiences were specialists in health-related fields, colleagues, or patients. Interestingly, 66% of the respondents (response rate: 42%; n = 80)

had received media attention. The respondents thought that the media attention might be due to their long-term blogging and the time and attention they dedicated to the Web and to medical news in the blogosphere.

A majority of research blog authors are men. In a survey of bloggers (n=44) from SciLogs, a German blogging platform, 73% of the respondents were male (Puschmann & Mahrt, 2012). In Shema et al.'s study of RB blogs and bloggers, 76% of the blogs had at least one male author. Men were less prominent in medical blogging, but were still the majority (59%) in Kovic et al.'s medical bloggers study.

In Puschmann and Mahrt's (2012) investigation of the SciLogs platform, over 60% of the 44 respondents considered the presentation of their fields to the general public to be an important goal. About half saw having an online presence as important and 35% wanted to bring difficulties and controversies to the public's attention. Only a minority (one-fourth) wanted to blog about their own research, though many (over 60%) considered exchanging ideas and discussions in their blogs to be important. For most SciLogs bloggers (80%), the main audience was the general public, with less wanting to communicate with colleagues (44%) and students (42%).

ResearchBlogging.org (RB) was launched in late 2007 as an aggregator of blog posts referencing peer-reviewed research in a structured manner, similar to the references in scholarly discourse. RB employs human editors in order to ensure that blogs aggregated in RB post about peer-reviewed research and are not overly commercialized. After being accepted to the aggregator, bloggers can use the RB icon to identify posts about peer-reviewed research. The RB icon also gives a blog and its blogger(s) credibility, acknowledging that they are aware of the academic system of credit allocation. The RB icon is a tick, a traditional symbol of approval. At least one blog has been removed from RB due to misuse of the icon to disseminate studies of creationism which were not peer-reviewed (Batts, Anthis & Smith, 2008).

RB was first studied by Groth and Gurney (2010) who focused on the Chemistry category. They found that blog references were mostly recent and referred to articles in top-tier journals. Studies by Shema, Thelwall and Bar-Ilan (2012a; in press) and Fausto et al. (2012) showed that the most popular journals in RB were (in alphabetical order): Nature, the open-access journal PLoS ONE, Proceedings of the National Academy of Sciences of the United States of America (PNAS) and Science.

Research blogs and bloggers in general, and RB in particular, have a number of typical characteristics. Luzón (2013) noted that the RB icon appeared in many research blog posts, although the focus of her study was research blog posts in general rather than RB posts. Fausto and her colleagues (2012) found that from its launch in late 2007 until the end of 2011 RB aggregated about 27,000 posts from over 1,230 blogs. In addition, they

found that RB in this period mainly aggregated posts discussing Biology (36%), Health Sciences (15%, a combination of the RB categories Health and Medicine), Psychology (13%) and Neuroscience (9%). English is RB's most prominent language, although it also aggregates Spanish, German, Italian, Polish and Chinese (Fausto et al., 2012). In agreement with Puschmann and Mahrt's report of little interest in self-citing, Shema, Bar-Ilan and Thelwall (2012b) found little self-citation among bloggers in four of RB's categories. Self-citation rates ranged from 10% (in the Mathematics category), and 9% (Computer Science and Philosophy) to 5% (Ecology). Research bloggers, whether they aggregate in RB or not, seem to be well-educated and related to the academic world. Puschmann and Mahrt (2012) found that 45% of their bloggers held a doctorate. Forty-three percent of the bloggers in Puschmann and Mahrt's study had achieved a *Mitarbeiter*, which is "a usually non-tenured research or teaching position that is generally held prior to achieving the status of Professor." (p. 176) and 9% "have achieved a status of Professor (assistant, associate, or full)" (p. 176). Kovic et al. (2008) found that 71% of research bloggers have a Master's degree or a doctorate. Shema, et al. (2012) showed that 59% of RB bloggers were affiliated with a research institute in some way, 27% were graduate students and 32% held a PhD, further evidence for research bloggers' familiarity with the academic world.

The current study

This research is part of recent attempts to map the relatively uncharted territory of scholarly impact in social media. Microblogging, academic bookmarking, social networks and other services are all potential sources of alternative metrics, or altmetrics. The new metrics will complement the older, citation-based ones and allow us to better understand and evaluate scholarly impact. As Taylor put it: "*In retrospect, the period during which we relied upon formal citation of article-by-article as a measurement of usage, quality, and impact will appear to have been primitive.*" (Taylor, 2013, p. 27).

Research blogs have lately emerged as a potential source of altmetrics. In a study of 2009-10 RB posts Shema et al. (in press) showed that articles which were covered by RB posts in their year of publication (e.g., a 2010 article covered by a 2010 post) tended to have, as a group, a citation advantage over articles from the same journal and year that were not covered by blogs. Thelwall, Haustein, Larivière and Sugimoto (2013) studied articles covered by the blogging networks Nature.com, ResearchBlogging.org and ScienceSeeker, another research blogging aggregator (not limited to posts with structured references). They found that among articles covered by blogs, those which received more blog coverage were associated with higher citation rates.

The potential of research blog references as an alternative metric source has created a need for content analysis investigations into bloggers' motivations, similar to those conducted on the motivations for peer-reviewed journal references. Unfortunately,

bloggers often give only a general list of sources, rather than attributing each piece of information to its source. Therefore, we could not classify the motivations behind individual references and opted for classifying the motivations behind complete posts instead, focusing on the RB category ‘Health.’ Our aims were to shed light on the motivations behind individual posts and to develop a classification scheme applicable to research blog posts in general. Our set of research questions is as follows:

RQ1: What are the main characteristics of references in research blogs and do they match those found in other studies?

RQ2: What are the typical motivations for blog posts citing academic research?

RQ3: What, if any, do the posts’ motivations have in common with motivations of journal-based citations and Web citations?

Methods

ResearchBlogging.org publishes an extended snippet of all the posts that it aggregates. An example of such a snippet can be seen in Figure 1. All the snippets of posts published during 2010, 2011 and 2012 were downloaded using the DownThemAll add-on to Firefox (<http://www.downthemall.net/>).



 **Is America Less Mentally Healthy Than A Chilean Jail?** Medicine
Psychology
Social Science

by Neuroskeptic in Neuroskeptic_Discover

October 12, 2013
11:01 AM
7 views

The average prison inmate in Chile has better mental health than the average American citizen, according to an eyebrow raising report just published. Researchers Adrian Mundt and colleagues ran a random survey of 1000 participants from among Chile's 47,000 prisoners. Fieldworkers went into the prisons and aimed to determine rates of DSM-IV diagnoses. They found [...]The post Is America Less Mentally Healthy Than A Chilean Jail? appeared first on Neuroskeptic.... [Read more »](#)

Mundt AP, Alvarado R, Fritsch R, Poblete C, Villagra C, Kastner S, & Priebe S. (2013) Prevalence rates of mental disorders in chilean prisons. PLoS ONE, 8(7). PMID: 23894415

Figure 1: a typical RB snippet

We extracted the Health category posts by searching for the word Health in the “category” field. The combined number of 2010-2012 snippets in all categories was 20470 (2010 = 7770; 2011 = 6905; 2012 = 5795).

We selected 10% of the Health category posts at random. The 391 sampled posts were written by 134 bloggers in 130 blogs during 2010-2012 (some bloggers wrote in more than one blog, and some blogs had more than one author). Posts with broken links were replaced with other randomly-selected posts from the same year and category.

We developed a coding scheme based on common post themes. First, we read a number of posts to familiarize ourselves with their typical contents and to suggest motivations for the coding scheme. A primary scheme was developed based on this reading. At first, many motivations had an “expert” version (e.g., bloggers giving advice to colleagues) and a “public” version (e.g., giving advice relevant to non-experts). However, these were collapsed into one motivation in order to keep the scheme as simple and clear as possible. The first author then coded all the posts from the sample for apparent motivations, while the second author coded separately about 10% of the posts. The coders compared their work; disagreements were discussed until a consensus had been reached. The inter-coder reliability was 86%. We clustered the motivations that emerged from the posts into 10 categories, each named after their function.

- *Discussion* – consideration and examination of an issue. The subcategories of this topic are:
 - Discussing factors which influence a health condition/life style
 - Discussing social phenomena
 - Discussing a public health issue
 - Discussing treatment for health conditions
 - Discussing possible practical/social outcomes of a research
 - Explaining the importance of scientific findings
 - Discussing a condition/health problem
 - Review of current knowledge about a subject

- *Criticism* – finding fault with a research-related issue. The subcategories are:
 - Raising methodological issues
 - Criticism of a practice
 - Disputing a belief
 - Criticizing an article’s conclusions/recommendations
 - Criticism of media coverage/press release, which is related to the article(s) covered

- *Advice* – Recommending actions for the readers. The subcategories are:
 - Providing practical advice and recommendations (e.g., having a gastric bypass rather than a gastric banding)
 - Advocacy against certain treatment/life style/intervention

The “Advocacy” subcategory is used when the blogger does not merely give an advice, but strongly rejects a course of action (e.g., marketing energy drinks for kids).

- *Trigger* - a direct stimulus for post writing that was mentioned in the post. The subcategories are:
 - Reaction to a topic in the news/current event
 - Invitation for further discussion in the comments
 - Reaction to a question/comment by blog readers
 - Reaction to another blog post
 - Announcing the publication of a new article

- *Extensions*– suggesting possibilities beyond the post’s scope. We included in the category:
 - Recommending other material (e.g., further reading, podcast)
 - Suggestions for possible future research.

- *Self* – The bloggers added post content which was specifically related to them. The category includes:
 - Sharing personal experience related to the blog post topic.
 - Self-citation, referring to the blogger's own peer-reviewed article in the post.

- *Controversy* – Discussing controversy; explaining and/or discussing disagreements (e.g., is BMI an appropriate index to use in elderly weight management?)

- *Data* – Providing data and facts with practical implications; background factual information about the blog post subject.

- *Ethics* – Discussion of ethical questions (issues of morality).

- *Other* – Grouping of posts that were classified as “other” in another category.

All motivations could relate to issues concerning the general public, experts only, or both. For example, an ethical problem could be general (e.g., should dogs’ tails be docked?) or discipline-specific (e.g., is it ethical to prescribe a placebo to patients?).

In their blog research, Kousha, Thelwall, and Rezaie (2010) considered all mentions of scholarly material in blogs as citations. However, in our previous work (Shema et al., in press) we differentiated between *blog mentions* and *blog citations*. Blog mentions are

any sort of reference to scholarly material in blogs, while blog citations cite scholarly materials in a structured, formal style (e.g., APA, MLA) in the blog post.

In order for a post to be eligible for aggregation in RB, it has to contain an HTML code representation of at least one structured reference. The code is automatically generated by entering bibliographic details (e.g., year, journal) into an RB form. Optionally, other post sources can also be referenced in a structured manner. In the current study we used the definition of Kousha et al. (2010) and considered every mention of a scholarly source to be a reference, in order to gather as much information about scholarly sources in blogs as possible.

Table 1. Number of structured and unstructured references in the 391 sampled RB blog posts from 2010-2012.

	2010	2011	2012	2010-2012
Number of posts	159	134	98	391
Overall references	246	299	254	799
Structured	182 (74.0%)	182 (60.9%)	230 (90.6%)	594 (74.3%)
Unstructured	64 (26.0%)	117 (39.1%)	24 (9.4%)	205 (25.7%)

***Note that an article which was cited, for example, 3 times in 3 different posts, was counted 3 times.**

As shown in Table 1, there was a decrease in posting from 2010 to 2012. This aligns with Fausto et al.'s (2012) study of all RB categories. They reported that 2010 was a peak year for RB posting, followed by a decrease to 2009 posting rates in 2011. They suggested the decrease might be due to increased usage of social networks (e.g., Facebook and Twitter).

Results

This section describes blog reference characteristics and the apparent motivations behind the selected blog posts. We first report the distribution of publication years for articles cited in the sampled posts. Second, we present the distribution of blog references according to publication types and the most popular journals cited in blog posts, as well as the Web of Science (WoS) categories that they belong to. Next, the distribution of blog references is given according to the extent of negation. Last, a distribution of apparent motivations behind blog posts is discussed using representative examples of popular motivations.

It should be noted that a small number of sources each year were officially published in the year after their citing post's publication (see Table 2). We assumed that the bloggers referred to 'early view' online versions in these cases.

Table 2. Structured and unstructured blog post references by cited article publication year (rows) and blog post publication year (columns).

2010 (n=246)			2011 (n=299)			2012 (n=254)		
2011	4	1.6%	2012	3	1.0%	2013	3	1.2%
2010	132	53.7%	2011	109	36.5%	2012	97	38.2%
2009	24	9.8%	2010	41	13.7%	2011	33	13.0%
2008	20	8.1%	2009	20	6.7%	2010	19	7.5%
2007	9	3.7%	2008	20	6.7%	2009	19	7.5%
2004-06	25	10.2%	2005-07	42	14.0%	2006-08	19	7.5%
2001-03	5	2.0%	2002-04	26	8.7%	2003-05	22	8.7%
1996-00	16	6.5%	1997-01	23	7.7%	2000-02	14	5.5%
1990-95	7	2.8%	1991-96	5	1.7%	97-99	6	2.4%
1968-94	4	1.6%	1960-95	9	3.0%	1961-96	21	8.3%
			n.d.	1	0.3%	Submitted	1	0.4%

In the sampled blog posts from 2010, over half of the references were to articles that had been also published in 2010. In the sampled blog posts from 2011 and 2012 a little more than half of the references had been published in the previous two years, with about one third originating from the previous year. The results are similar to those from previous RB studies (Groth & Gurney, 2010; Shema et al., in press). The pattern also fits with the fast-moving pace of information of many biomedical fields (Glänzel & Schoepflin, 1999; Moed, 2005).

Journal and publication types

We classified each reference, whether structured or unstructured, according to its WoS publication type. When a document was not indexed in WoS, we classified it according to its PubMed entry, when present. We classified as “other” sources which did not fit into any category (e.g., a presentation) and articles that did not have a classification in either WoS or PubMed.

Table 3: Types of publication cited in the sampled blog posts.

Year	2010-2012
Research article	566 (70.8%)
Review	113 (14.1%)
Editorial material	25 (3.1%)
Book	19 (2.4%)
Various government UN and non-for-profit organizations	19 (2.4%)
Proceedings/meeting abstract	16 (2.0%)
Letter/note	14 (1.8%)
News item from a peer-reviewed journal	6 (0.8%)
Other	21 (2.6%)
	799 (100%)

The main publication type was the research article (70.8%) with reviews second (14.1%) and editorials (3.1%) third. It seems that despite the multidisciplinary and medical journal tendency to publish many editorials and letters, the bloggers focused instead on research articles and reviews. The distribution of publication types referred to by blogs seems to be similar to the distribution of highly cited documents found by Aksnes (2003).

Table 4: The 20 most frequent peer-reviewed journals and their WoS categories

Journal	Frequency 2010-12	%	Category
PLoS One	25	3.1	Multidisciplinary Sciences
NEJM	19	2.4	Medicine, General and Internal
Science	18	2.3	Multidisciplinary Sciences
British Medical Journal	18	2.3	Medicine, General and Internal
Nature	15	1.9	Multidisciplinary Sciences
Lancet	14	1.8	Medicine, General and Internal
PNAS	13	1.6	Multidisciplinary Sciences
Pain	12	1.5	Anesthesiology/Clinical Neurology/ Neuroscience
PLoS Medicine	11	1.4	Medicine, General and Internal
Pediatrics	11	1.4	Pediatrics
Journal of Autism and Developmental Disorders	10	1.3	Psychology, Developmental
JAMA-Journal of the American Medical Association	9	1.1	Medicine, General and Internal
OTJR-Occupation Participation and Health	9	1.1	Rehabilitation
Archives of Internal Medicine	8	1.0	Medicine, General and Internal
Environmental Health Perspectives	6	0.8	Environmental Sciences/ Public, Environmental & Occupational Health
European Journal of Pain	5	0.6	Anesthesiology/Clinical Neurology/ Neuroscience
Annals of Internal Medicine	5	0.6	Medicine, General and Internal
Medicine and Science in Sports and Exercise	5	0.6	Sport Sciences
PLoS Biology	4	0.5	Biochemistry & Molecular Biology/ Biology
Obesity reviews	4	0.5	Endocrinology & Metabolism

As in previous studies (Groth & Gurney, 2010; Shema et al., 2012a; Fausto et al., 2012), the bloggers showed a preference for high-impact journals (Table 4). The multidisciplinary journals Science, PLoS One, Nature and PNAS were prominent, as well as top-tier general medical journals and several journals from specific niches (e.g., autism, sports, obesity) related to health.

Negational posts

Although we attempted to classify each reference according to its function, the bloggers often did not attribute pieces of information to their exact source. Therefore we were only able to roughly classify the references as confirmative, partly negational and negational.

We considered every reference to be confirmative unless the blogger specifically treated it otherwise, assuming that a decision to discuss scholarly material without explicitly criticizing it showed that the blogger believed it to be broadly correct. We considered references to be partly negative in cases where the blogger rejected certain elements of the article but accepted others. References were classified as completely negational when the blogger rejected the findings or conclusions of the cited material altogether.

We did not consider methodological issues as fully negational unless the blogger regarded them as compromising the article's conclusions or recommendations. The partly negational references do not follow Chubin and Moitra's definition of partial negational citations (1975), since bloggers do not always offer a correction to the part of the article that they consider to be incorrect.

An example for a partly negational reference:

But why look at the consumption of "social drugs" in people who are depressed? Aren't these individuals less inclined to be social? And aren't they likely to show anhedonia (loss of interest of pleasure) according to DSM IV criteria? (The Neurocritic, 2011)

In this case the blogger found what he considered to be flaws in the article, but did not dispute the results altogether later in the post, despite these flaws.

In an example of a completely negational reference, a blogger quoted a sentence from an article:

The salient observation in this study is that adding amiodarone to advanced cardiac life-support measures resulted in a net benefit

He then went on to give his extremely negative opinion:

*Survival to admission is a net benefit? A lot more patients dying in the hospital is a net benefit? **Survival to discharge is a real benefit.** Imagine telling a patient's family –*

Table 6: Frequency of blog post motivation, 2010-2012

She died, but she lived long enough to acquire thousands of dollars in hospital

Table 5: Classification of the extent of negation in the sampled blog references according to their post context.

	2010	2011	2012
Confirmative	234 (95.1%)	284 (95.0%)	249 (98.0%)
Partly negational	8 (3.3%)	9 (3.0%)	2 (0.8%)
Negational	4 (1.6%)	6 (2.0%)	3 (1.2%)
Overall references	246	299	254

bills. We consider this a net benefit. A surrogate endpoint is not a real benefit!
(Noonan, 2010, ¶ 13).

Classification of the apparent motivations behind blog posts

We classified the apparent motivations for the sampled blog posts into ten major motivation categories (described in the methods section). There were no major changes in the content frequencies over the years, and therefore we show only the combined frequencies for 2010-2012 (Table 6). The percentage column reports the percentage of motivations from the category appearing at least once in a post (n=391). We discuss examples of motivations that appeared at least 30 times in posts, as well as the motivations from small categories - categories that do not have a single motivation which appeared more than 30 times, but appeared more than 30 times as a whole (e.g., Self). The number of motivations per post ranged between one and seven, with an average of 2.8.

Category	Motivation	Overall frequency (2010-2012)	% out of number of posts
Discussion	Discussing factors which influence a health condition/life style	172	44.0%
Discussion	Discussing social phenomena	109	28.1%
Discussion	Discussing a public health issue	88	22.5%
Discussion	Discussing treatment for health conditions	60	15.3%
Discussion	Discussing possible practical/social outcomes of a research	50	12.8%
Discussion	Explaining the importance of scientific findings	31	7.9%
Discussion	Discussing a condition/health problem	29	7.4%
Discussion	Review of current knowledge about a subject	20	5.1%
Overall discussion frequency		559	89.3%
Criticism	Raising methodological issues	39	10.0%
Criticism	Criticism of a practice	35	8.9%
Criticism	Disputing a belief	33	8.4%
Criticism	Criticizing an article's conclusions/recommendations	16	4.1%
Criticism	Criticism of media coverage/press release, which is related to the article(s) covered	8	2.0%
Overall criticism frequency		131	29.9%
Advice	Providing practical advices and recommendations	100	25.6%
Advice	Advocacy against certain treatment/life style/intervention	8	2.0%
Overall advice frequency		108	27.1%
Trigger	Reaction to a topic in the news/current event	33	8.4%
Trigger	Invitation for further discussion in the comments	19	4.9%
Trigger	Reaction to a question/comment by blog readers	10	2.6%
Trigger	Reaction to another blog post	5	1.3%
Trigger	Announcing the publication of a new article	3	0.8%
Overall trigger frequency		70	17.9%
Extensions	Recommending other material (reading, podcast, video, etc.)	36	9.2%
Extensions	Suggesting future research directions	37	9.2%
Overall extensions frequency		73	18.2%
Self	Sharing personal experience	20	5.1%
Self	Self-citation	12	3.1%
Overall self frequency		32	8.2%
Controversy	Discussing controversy	45	11.5%
Data	Providing data and facts with practical implications	21	5.4%
Ethics	Discussion of ethical questions	17	4.6%
Other		31	7.9%
Overall motivation frequency		1087	

Discussion of research

“Discussion” was the largest category, appearing in 89.3% of the posts. It included motivations which fit a large variety of posts. The most popular subcategory was “Discussing factors which influence a health condition/life style” (present in 44.0% of the posts). In a post dealing with the prevention of diarrhea, for example, the blogger starts preparing the ground by listing factors that influence diarrhea spreading:

Poor hygiene, inadequate sanitation and lack of clean, safe drinking water all contribute to the spread of the harmful viruses, bacteria and parasites that cause diarrhea. (Geek!, 2011, ¶ 2).

The motivation “Discussing social phenomena” was found in 28.1% of the posts. In a post titled “Talking therapies for depression are overrated thanks to publication bias” the blogger discussed a common social preference and the way it relates to the cited article’s conclusions:

Think about it – patients, researchers and editors are going to be more interested in studies showing that a treatment has a considerable effect on a condition than those showing that the treatment has only a negligible effect. (Jaques, 2010, ¶ 3)

Posts were classified as “Discussing a public health issue” (in 22.5% of the posts) when dealing with either the prevention of health conditions or with the promotion of health. One post discussed, for example, both the prevention of obesity by taxing unhealthy food and the promotion of normal body weight by subsidizing health food:

If we're looking to use pricing to motivate healthier dietary choices sticks (taxes) may well work better than carrots (subsidies). (Freedhoff, 2010. last ¶)

We classified a post as “Discussing treatment for health conditions” (15.3% of the posts) when the post dealt, for example, with efficacy of treatment: “*Antidepressants were no better than placebo in patients with ‘minor depressive disorder’*” (Neuroskeptic, 2011a; ¶ 2).

The “Discussing possible practical/social outcomes of a research” category (present in 12.8% of the posts) was used when posts discussed the implications of research. In the post “Cigarettes: should the FDA mandate a national taper?” dealing with a suggested reduction of nicotine in cigarettes, the blogger points out a possible challenge: “*But would a robust black market in strong cigarettes leap up if nicotine reduction were a federally mandated program?*” (Hanson, 2012, ¶7).

The “Explaining the importance of scientific findings” category (7.9% of the posts) was used when bloggers specifically emphasized the importance of the studies they referred to. For example: *“This study is important because it clarifies the level of experience, knowledge, and perceptions among marathon runners”* (Driban, 2011, ¶2).

Criticism

This category groups all criticism found in posts. The category’s prominence (29.9% of posts) might be unexpected given that most references in academic articles and in our study (Table 5) are confirmational, but criticism in posts was not necessarily directed at the referenced articles. A blogger can refer to a scholarly article in order to dispute a belief put forward through the media:

Mr. Sherwood is the President of the Canadian Beverage Association and just this week he was tasked with defending sugar as a contributor to obesity, diabetes and heart disease.

Let's review Mr. Sherwood's letter, but seen through the lens of Kelly Brownell and Kenneth Warner's Big Tobacco Playbook - whereby they came up with a list of plays that the food industry has co-opted from the early days of the fight to prove tobacco harmful. (Freedhoff, 2012, ¶3)

In this case the blogger contradicted claims put forward in a press release, using the peer-reviewed article he referred to as a “road map.”

Two sub-categories (“Raising methodological issues” and “Criticizing an article’s conclusions/recommendations”) dealt with criticism directed at the posts’ scholarly sources. Since most articles have methodological challenges to some degree, criticism of methodological issues was often mild:

Unfortunately, this research review found no studies in prescription opioid abusers as the only studies in opioid abuse/dependence were done in heroin or methadone users (Yates, 2012, ¶ 8)

The blogger above mentions a weakness of the review article, but the weakness is technical rather than the article’s authors being at fault. Of course, criticism of research methodology can also be harsh:

Russel Lyons who posits that Christakis' and Fowler's work is a great example of statistical illiteracy, and that the conclusion drawn from their data, that obesity is socially contagious, is severely flawed and can't be made. (Freedhoff, 2011, ¶ 2)

In this case, the post focused on a controversy concerning a high-profile article, with methodological issues being at the heart of the discussion. This was in line with Cole and Cole's argument (1971) that a scholarly work has to be noteworthy to merit criticism.

While "Raising methodological issues" appeared in 10% of the posts, "Criticizing an article's conclusions/recommendations," was less common (4.1% of the posts). We considered the suggestion of an alternative hypothesis to be a form of criticism, since the blogger must have considered explanations by the cited articles' authors to be inadequate:

The author hypothesizes that the electrostatic potentials themselves were communicating through the skin into the corpus callosum of the penis, and causing the rats to exhibit erectile dysfunction.

Sci's [the blogger] not so sure about this. IS it the electrostatic potential? What about heat? And what about the severe embarrassment of wearing polyester pants? (Brookshire, 2011, ¶ 11-12)

Another motivation in this category was "Criticism of a practice" (present in 8.9% of the posts). A blogger can criticize common guidelines:

The current recommendation for epinephrine is based on this same misconception. More ROSC = better outcomes - except that the dogma is not supported by any evidence. (Noonan, 2009, ¶5)

The "Disputing a belief" class appears in 8.4% of the posts (in 8.4% of the posts). In this case, bloggers correct a misconception. The belief can be one held by experts:

"The previous paradigm is that nuclei added after resistance are lost during atrophy is not supported, and the authors offer the following model instead" (Vorland, 2010, ¶ 9)

Or one held by the public:

“I hate to break it to you – even the most effective medication seems to only reduce pain by about 30%, and most people wanting pain reduction are after at least a 60% reduction.” (Thomson, 2010, ¶ 2)

Advice

There were two motivations in this category. One was “Providing practical advice and recommendations” (in 25.6% of the posts) and the other was “Advocacy against certain treatment/life style/intervention” (in 2.0% of the posts). Bloggers clearly preferred advising and recommending practices, treatments, and guidelines rather than arguing against them. Some advice was aimed at the general public:

“So the take home message from the study is that for those 50 or older if you are taking a daily nap and feel it helps you, keep doing it.” (Yates, 2011, ¶ 6)

Other advice was specific and targeted a professional audience:

Clinicians should note that because of the different mechanisms involved in the metabolic changes seen after bariatric surgery, both the time course and magnitude of changes in individual patients may be quite variable and in some cases hard to predict. (Sharma, 2010, ¶9)

Trigger

Triggers can come from mainstream media, from interactions with blog readers or with other bloggers, and from scholarly sources. Triggers were present in 17.9% of the posts.

Mainstream media triggers were the most common and appeared in 8.4% of the posts. A media trigger could be a news article about a subject related to health: “*A New York Times story grabbed my attention today, “Just Manic Enough: Seeking Perfect Entrepreneurs”*” (Mossop, 2010). In this case, the blogger expanded on a subject covered by the news media by searching the scientific literature and providing the readers with further knowledge about the phenomenon described by the media. The media also sometimes provided bloggers with post ideas without explicitly discussing research:

In honor of one of the most lucrative American holidays (link to a news story about the Super Bowl) happening this very weekend, I thought I'd explore sports and infectious diseases. Specifically, contact sports and skin infections! Since starting this blog, I've gathered that readers just love reading about transmissible skin infections, so what could be better than watching the Super Bowl and knowing just exactly what kind of diseases could possibly be smeared between the players of the Patriots and Giants? (Kreston, 2012, ¶1)

The Super Bowl, a major American sports event, is covered extensively by the media. However, for the blogger the sports event is a trigger, an excuse to discuss a sports-related health issue.

Extensions

Extensions are parts of posts that suggest possibilities beyond a post's scope. One kind of extension is theoretical, "Suggesting future research possibilities," which can be found in 9.2% of posts. For example, a blogger who posted about representations of autism in the media suggests future comparison between autism and other disorders:

"I said that this paper is sadly brief. There's so much more to say on this topic; in particular, we need to compare representations of autism to those of other developmental disorders like Down's syndrome, in order to work out what's specific to autism as opposed to just general "disability" or "disorder"." (Neuroskeptic, 2011b, ¶ 8)

The second kind of extension is the recommendation, which directs the readers to additional resources. It can be found in 9.2% of the posts:

Wolfe's team is also engaged in viral monitoring in which they track zoonotic viruses with the assistance of bushmeat hunters in Cameroon.[...] You can check out his genuinely inspiring talk on TED and get a better idea of the project. (Kreston, 2011, ¶ 6)

In this case, the blogger discussed a scientist's research, referred to his scientific work at the end of the post, and in addition recommended a video about his work for readers who have special interest in the topic.

Controversy

The "Discussing controversy" categorization was given to 11.5% of the posts. The controversy can be in-field or regarding a public issue:

*Recently, there has been a push to mandate labelling in fast food restaurants and stores. In the US, this is a huge initiative, passed as part of the 2010 Health Reform Bill. [...] There's a lot of ammo on both sides: some think that people should be responsible for their food choices, and that restaurants shouldn't have to put up nutritional information. After all, they don't *force* you to eat it. On the other hand, others advocate that knowing what is in your food will help you make a more informed decision.* (Kukaswadia, 2011, ¶ 1-2)

If you recall, these studies lay at the heart of a serious debate concerning biosecurity and the publishing or not publishing of potentially dangerous results. (De Winter, 2012, ¶ 1)

Self

The “Self” class was invoked when bloggers disclosed a personal interest in a post’s topic. Some did so by “Sharing personal experience”, which appeared 20 times (5.1% of posts). For example, in a post about a connection between avoiding breakfast and weight gain in children, the blogger supported the research’s conclusions based, among other things, on his personal experience:

I know from personal experience that when on occasion I would miss breakfast, by the time 10:30am came around I was ravenous with particular craving for specific foods, namely of the greasy, high-calorie variety. (Janiszewski, 2011, ¶ 9)

Another “Self” motivation was the self-citation, or self-mention, where bloggers referred to their own scientific research. This was fairly rare, appearing only 12 times (3.1% of the posts):

*A few days ago, my first, first author paper was finally published in *Alcoholism: Clinical and Experimental Research*. (Brager, 2010, ¶ 1)*

The blogger here announced a personal achievement, publishing her first article as a first author, and gave a detailed explanation of her study in the post.

Other

The “Other” category (present in 7.9% of the posts) grouped together posts that were originally classified as “other” in each of the categories. A blogger linking to a presentation he gave, for example, was an “other” in the category “self.”

*Below I've embedded a copy of my presentation, which is on the paper "*Fitness of Canadian Adults: Results from the 2007-2009 Canadian Health Measures Survey*" (Link to presentation). (Saunders, 2010, ¶ 1)*

Discussion and Conclusions

This study analyzed 391 ResearchBlogging.org Health category blog posts from the years 2010-2012. The study was limited to 10% of ResearchBlogging.org's Health category English-written posts during 2010-2012. RB is an English-oriented, self-selected aggregator, which limited the sample to bloggers who chose to aggregate with it. Given the specific category, language, post source and years, some of the classifications we suggested would lose relevance when applied in other environments. Moreover, although the goal was to identify motivations in blog posts, the classification scheme is a typology of the content of the posts from the perspective of motivations rather than a direct classification of motivations. Hence, the classification scheme will not be able to capture implicit or hidden motivations, such as paying homage to a senior scholar by blogging about their research, or attempting to discredit a competitor by criticizing their findings.

An interesting finding was the low percentage (25.7%) of unstructured references (blog mentions). Perhaps bloggers see structured references in blogs (blog citations) as more of a persuading aid (Gilbert, 1977) than a property claim device (Kaplan, 1965), and hence seek formality when citing. In a world of links, the blog citation is highly visible because of its formal structure. If the Researchblogging.org tick icon is present then the aggregation with Researchblogging.org, even if not all sources are properly cited, can be reassuring to readers who are familiar with structured references. The persuasion relates to both the bloggers – they state they follow, at least in part, scholarly norms – and the content, which the readers know relies on information from a peer-reviewed journal.

The first research question related to the posts' scholarly sources. Much like earlier studies of RB (Groth & Gurney, 2010; Shema et al., in press), there was a preference for current research, with over half the references being either from the same year as the post in which they were cited or from the previous year. Nevertheless, it is perhaps surprising that a significant proportion of the blogged articles were old, including about 7% being at least 14 years old. Presumably the older articles were classics that are still relevant today. The distribution of publication types in posts resembles that of highly cited articles (Aksnes, 2003). Reviews are over-represented, while notes, letters, proceedings and editorials are under-represented in comparison with the general publication population. High-impact multidisciplinary journals were also prominent in the sample, as well as elite general medical journals, appropriate for the Health category. Again, this is in line with previous RB research, which found that bloggers tend to rely on prominent multidisciplinary and top niche journals (Groth & Gurney, 2010; Fausto, 2012; Shema et al., 2012a; Shema et al., in press). The second research question was also the main goal of the study: to create and apply a classification typology of the motivations behind blog posts referencing peer-reviewed articles. Some of the motivations identified fit only health blogs (e.g., treatment), however, but the remainder (e.g., "discussing social phenomena") can fit posts in many disciplines. For example, in the most popular

category, Discussion, 4 out of the 8 motivations are general rather than health-specific (e.g., “explaining the importance of scientific findings”)

Bloggers might be free from some restraints, but not from all. Most of the bloggers write under their own name (Kovic et al., 2008; Shema et al., 2012a), which makes them accountable for their words and might prevent them from voicing strong opinions about some subjects. We found a fair amount of criticism, but it was aimed at various targets and we cannot tell how, if at all, writing a critical blog post would affect a blogger's personal or professional status. Bloggers seem to predominantly accept the authority of the peer-review process and elite journals or choose to blog about articles that they consider to be reliable and valid, as Cole and Cole (1971) suggested regarding peer-reviewed journal article references. Direct criticism of peer-reviewed articles is not higher than its level in scholarly discourse but nevertheless, in almost 30% of the posts the bloggers chose a critical attitude towards issues being discussed. In this sense, research bloggers fulfill a role of citizen journalists. In addition, bloggers provided another public service: more than a quarter of posts gave advice and recommendations or advocated against life styles, interventions or treatments, showing the bloggers' interest in spreading helpful information for practical use.

Reference and post classification according to context face similar difficulties. We could not “*step inside that individual's head*” (Cronin, 1984, p.50) but classified at face value. There are, of course, many differences. One difference is that research blog posts are not products of independent research, but are derived out of other sources, including scholarly works. Blog posts do not, for example, present new research evidence that can confirm or deny previous works. Another difference is that while citers are obligated to follow formal scholarly norms regarding references, bloggers are not. They do not have to justify their blogging choices and can blog for no other reason than taking an interest of an article's subject. In some cases the informal nature of blogs might be an advantage in tracing bloggers' motivations, since it allows them to share motivations in a way that is not acceptable in formal discourse. Peer-reviewed articles' authors do not often reveal their informal motivations for referencing decisions (e.g., they just read an interesting news article). In blogs, however, the Trigger category (bloggers specifying a motivation behind their post) was present in almost one-fifth of the posts.

The rates of self-citation in the study are low, which is in line with the lack of willingness to discuss a blogger's own research found in Puschmann and Mahrt's study (2012) of German bloggers and the low self-citing rates found by Shema et al. (2012b) in other RB categories. Another reason for the low percentage of self-citations might be that some bloggers were not authors of peer-reviewed articles, for example because they were undergraduates or junior postgraduates.

The third research question compared motivations behind blog posts to motivations for journal-based citations and Web citations. We believe that blog citations and mentions can be classified under Jespen et al.'s "scientifically related" (2004), under Vaughan and Shaw's "other intellectual impact," (2005) or under "informal impact" (Kousha & Thelwall, 2007). In all the schemes, these categories represent unofficial material related to academia, which is not taken into account by today's indices.

Alternative impact metrics have grown in popularity in the recent years, but the meaning of the impact they measure is still vague. Given the findings of Thelwall et al. (2013) and Shema et al. (in press) regarding the association between research blog coverage and higher rates of citations, further investigations are needed into the motivations behind research blogging in order to cover other disciplines. This will allow more nuanced interpretations of altmetric results.

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