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ERRORS IN BIBLIOGRAPHIC CITATIONS: A CONTINUING PROBLEM

James H. Sweetland[1]

Bibliographic references are an accepted part of scholarly publication. As such, they have been used for information retrieval, studies of scientific communication, collection development decisions, and even determination of salary raises, as well as for their primary purpose of documentation of authors' claims. However, there appears to be a high percentage of errors in these citations, seen in evidence from the mid-nineteenth century to the present. Such errors can be traced to a lack of standardization in citation formats, misunderstanding of foreign languages, general human inabilities to reproduce long strings of information correctly, and failure to examine the document cited, combined with a general lack of training in the norms of citation. The real problem, the failure to detect and correct citation errors, is due to a diffusion of responsibility in the publishing process.

Bibliographic citations have been an accepted part of the scholarly paper for centuries [1], apparently developing their modern detailed format about the middle of the nineteenth century [2, pp. 64–65]. In view of their role in scholarly communication, students of citation practice have attempted to probe into the reasons for citations, developing detailed classifications of their roles and functions [3, 4]. However, these traditional roles can still be readily summarized by the following: "to enable the reader to obtain the immediate historical background of the problem and any previous attempts to solve it . . . ; [to provide] more complete

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descriptions of the apparatus used or . . . of the apparatus or method from which the present one was evolved . . . ; [to support] any outside data, facts, equations, or arguments employed . . . ; [to list] papers reaching similar or opposed conclusions" [5, p. 263]. Essentially, these studies have approached the role of the citation from the author's point of view. However, another way of looking at the citation is to consider the use to which it is put by the reader. In particular, the last four decades or so have seen more attention given to the reader's use of the citation beyond direct verification of the author's claims. In essence, there are four such functions of the citation.

The first of these "reader functions" is information retrieval, most highly developed in the citation indexes produced by the Institute for Scientific Information (ISI), beginning with the *Science Citation Index* in 1963. These indexes are based on the assumption that the citing paper has something in common with its citations and that both citing and cited works are related by subject, an assumption rooted in nearly all the traditional reasons given for the use of citations. Since citation indexes tend to retrieve documents not found by traditional subject-word searching, they have become quite popular as a supplement or an alternative to traditional subject-word retrieval [6].

A second function of citations is actual document retrieval. Since few libraries or personal collections contain even a large fraction of all potentially relevant documents, much research requires some form of remote document delivery, such as interlibrary loan. While the standard assumption of the national interlibrary loan code is that an item will be verified in "basic bibliographic tools," the code also permits the use of a citation from a known document [7].

A third use of citations has been in the fields of "bibliometrics" and "scientometrics." Since the 1940s the use of citations to develop rankings of the journals, publishers, and authors in various fields has become common, as has the use of this information to develop maps of the "invisible colleges" and the influence of new scientific discoveries [8]. Finally, a more immediate and practical application of bibliometrics is the apparently increasing use of citation counts to determine faculty and researcher productivity for such purposes as tenure decisions, contract renewals, and merit salary increases [9, 10, 11].

However, whether one considers bibliographic references from the point of view of the author or the reader, the assumption is that the citations are accurate. Unfortunately, considerable evidence exists that suggests such an assumption is questionable. Much of this evidence tends to be anecdotal, generally discussing the difficulties resulting from some problematic references found by one reader. A substantial portion of such evidence on the accuracy of citations is in the biomedical literature.

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Perhaps the earliest complaint of this type is that of Aristide Verneuil, a noted surgeon and scholar, who complained it took him about six hours to trace one fact through a series of incorrect and incomplete citations. While written in a semiserious tone, his article made the point that the time wasted would have been better spent had his predecessors been more careful in their citations [12].

As the number of scientific papers increased, the need for correct citation became clearer. Presumably, this need was addressed by the publication of style manuals, first seen around the turn of the century. The earliest to appear were *Hart's Rules for Compositors and Readers* (1893) and the University of Chicago *Manual of Style* (1906). The earliest such rule book to apply to scientists, Sir Clifford Allbutt's *Notes on the Composition of Scientific Papers,* was published in London in 1904, although no American equivalent appeared until Trelease's *Preparation of Scientific and Technical Papers* in 1925 [13].

Unfortunately, citation errors continued to appear, as did an increasing number of complaints about them. Frank Place, for example, attempted to get his medical colleagues to exercise more care in a jocular 1915 paper [14] and a more serious "word to medical writers" in 1916 [15]. In the latter, he notes the danger of neglecting to check the original document, giving the example of a Finnish paper by a J. V. Hjelmman, abstracted in a French journal. This abstract was then translated into English in the *Medical Bulletin* (Philadelphia) citing only the French journal, and giving the author as J. V. Hieleman. The translation was then reprinted verbatim in the *St. Louis Medical and Surgical Journal,* now citing *Bull. Med. and Surg.* From here a number of other journals garbled the reference even further [15, p. 699].

Perhaps the most amusing, and long lasting, miscitation is the strange case of "Dr. O. Uplavici." In 1887 Dr. Jaroslav Hlava published a paper on the role of amoebas in dysentery, using cats as experimental animals. The paper is quite important in the field, as was Dr. Hlava. The original paper was written in Czech and apparently became widely known through a German language abstract. Unfortunately, the *Centralblatt für Bacteriologie und Parasitenkunde* mistakenly omitted the author's name, entering the item under its title—in Czech, "O Uplavici" (this translates as "On dysentery"). This error was then repeated in various ways (O. Hlava, Uplavici Hlava, O. Hlava [O. Uplavici], etc.) until its appearance in the *Index-Catalogue of Medical and Veterinary Zoology* (1910), where the "author" O. Uplavici was listed with a doctorate. The errors continued until 1938, when the whole story was finally laid out by Clifford Dobell [16].

Similar, although less gross, cases continued to appear in the literature. For example, an article on splenic aneurysm by Lindblom was abstracted in *Pathologie der Kreislauforgan* and eventually was credited as

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appearing in that source, and credited to Lindbora, Lonkblom, and Lindbom by various writers. Another apparently straightforward reference to a paper by C. S. Langenbeck turned out to be by Simon Gustav, appearing in the journal *Langenbeck's Archiv* (published, not authored, by Langenbeck). Even if the title and journal are correct, the author may be very wrong, as in the case of a paper cited as by the "brothers" Levin and Gordon Derrick, who turned out to be S. A. Levine, B. Gordon, and C. L. Derick [17].

It has been argued that the norms and style of citation changed about the end of World War II [1, pp. 392–93]. While this may be true, the change seems to have made little improvement in citation accuracy, as a number of letters in both *Science* and *Nature* make clear. The former published a letter noting six references to the same paper in different articles in an issue of the *Journal of Geophysical Research:* two were correct; three had the wrong volume; and one had the wrong pages. The four errors, by the way, included one by the author of the cited paper [18]. To complete the cycle, a later letter noted the author of the critique had miscited the date for the issue of the *Journal of Geophysical Research* in question [19].

The letters in *Nature* discuss a number of errors in citation of authors' names, beginning with the plaint of a Dr. Cater, who noted that over two thirds of the reprint requests he received called him Dr. Carter [sic], even though both the table of contents and the article header listed him correctly [20]. Apparently inspired by Cater, two later writers noted that the affiliation M. R. C. PATH and the degree M. A. Cantab. had become "authors" [21, 22], the former even receiving the respectability of a listing in *Excerpta Medica.*

The problem is not unique to the United States, or even the English language. Similar examples of miscited page numbers, incorrect and misleading journal titles, and wildly misspelled authors' names have been given by Australian [23] and French librarians [24], and an Italian editor [25]. While amusing, and apparently indicative of carelessness, a few cases do not, by themselves, indicate a major problem. Unfortunately, comparative studies suggest there is indeed a problem. Such comparative studies can be divided into two types: those that are a side effect of another work and those formally undertaken as accuracy studies. The oldest comparative study is of the first type: Jacob Wolff's preface to *Die Lehre von der Krebskrankheit, part II* notes that, in the course of examining about 10,000 citations up to 1909 in preparation of his monumental work on cancer, he found "almost ten percent" in error [26, pp. v–viii].

Surprisingly few citation studies discuss the potential for error in their data. One of the few to do so indicated problems both in the citing

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articles' bibliographies and in the *Science Citation Index* (*SCI*), which listed them. Errors in citing articles included one lacking journal title, eleven incorrect journal titles, and one use of the same abbreviation to refer to two different journals ("Ann Phys" used for both *Annalen der Physik* and *Annales de Physique*). The authors also noted "many" instances of incorrect author initials and three misspellings of the cited author's surname. The *SCI* errors include an apparent tendency to cite only one reference when two or more were listed under a single number in the citing article and a "number" of "minor bibliographic errors," which can lead to inability to find the citing article [27].

The difficulty with such studies, of course, is that they still remain quite impressionistic and fail to provide exact measures of errors. Unfortunately, formal comparative studies suggest the problem is widespread. Again, most of these studies discuss the medical literature.

Goodrich and Roland examined ten major U.S. medical journals. Of 2,195 citations published in 1975, they found a total of 29 percent in error, with a range of errors between 14 percent and 50 percent, depending on the journal [28]. These results were reinforced by another study later that year of articles accepted for publication in the *Archives of Physical Medicine and Rehabilitation,* which verifies all references before publication. The authors found 54 percent of all references were incorrect, with an additional 6 percent unverifiable [29]. A third study in the same field confirms the ongoing extent of the problem, finding errors of citation in 24 percent of references in six medical journals for 1984 [30].

The track record of authors in other scientific disciplines is not much better: Robert Poyer studied 2,496 references from 102 articles published in thirty-four "high impact" science journals for 1977. Of these, 2 percent were not verifiable, and another 15 percent were in error. It is interesting here that Poyer is the first writer to give both the number of *errors* and the number of *citations* in error—the 367 erroneous references included 466 mistakes, giving an average number of 1.25 errors per erroneous reference [31]. The most common errors were in author's name (surname or first name/initial), followed by those in date, volume, or pagination.

The situation in the social sciences is no more encouraging. Boyce and Banning, for example, studied *Personnel and Guidance Journal* and *Journal of the American Society for Information Science* for 1976. They found 11 percent of the citations in the former and 14 percent of those in the latter in error [32]. Boyce, cooperating with Funk in another study attempting to define "quality" in psychological journals, again noted many errors but did not distinguish between those in the original articles and those in *Science Citation Index,* nor did he quantify them [33].

While it is obvious that errors in bibliographic citations are common, it

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TABLE 1
SUMMARY OF STUDIES SHOWING NATURE OF CITATION ERRORS

	Boyce & Banning [32]	Goodrich & Roland [28]	Key & Roland [29]	Poyer [31]
Total citations	1,269	2,195	1,867	2,496
Erroneous citations	150	634	1,005	367
Type of problem:*				
Cannot verify	257	Not noted	15	48
Author name error	18	161	599	357
Article title error	38	334	463	Not noted
Journal title error	5	1	105	8
Entry error (date, volume, page)	70	110	190	101
Omission (in any category)	19	Not noted	218	Not noted

*A citation is listed in more than one category if it has more than one type of error.

is less obvious that such errors are a major problem. In effect, as long as the reader takes the author's word that information has been obtained from the documents cited, there is no problem at all (unless, of course, the citation is actually fraudulent). Problems arise when the reader attempts to use the citation. The nature of the problem depends on the specific use. For example, a "slight misspelling" in the author's last name is a major error for the user of the ISI citation indexes, where this name is the primary access point, while it is trivial if the user is looking up the reference in the actual journal. In the latter case, even a "grossly incomplete" citation is not fatal, as long as the journal title and volume (or year) is correct, since the user can check contents pages until the desired reference is found.

Unfortunately, few studies of citation error indicate the types of errors encountered. However, a general analysis of error types by "field" in which the error occurs can be made for four of the studies (see table 1). Key and Roland (one medical journal) [29] found the majority of errors in author names, as did Poyer (biological and medical journals) [31]. Goodrich and Roland (medical journals) [28] found the majority of errors in article title, while Boyce and Banning (information science; counseling) [32] found the majority in the citation entry. Taking these studies together, it is possible to obtain a general idea of the net effect of errors by considering the different purposes to which a citation may be put. Since some citations contain more than one error [31], the following figures are probably slightly high.

First, assume a user attempts to retrieve the cited item by actually going to a collection: errors in journal or book title will be fatal; those in

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author name or article title will be trivial; those in entry will cause extra work but can be overcome, assuming enough time (for example, as long as either the volume or date is correct, one can find the correct journal article by inspection of two items). If the library user tried to find all items cited in the four studies, it would have been impossible 119 times, or about 2 percent of the time, due to errors in document title. On the other hand, attempts to obtain the items at a distance involve a different set of needed information. Since the supplier will normally provide the user only what is requested, errors in citation (in addition to journal or book title) will result either in the wrong item or in a "can't find" response. Adding the 471 entry errors to the 119 title errors gives a total of 590 problems, or a failure to obtain the item (for example, via interlibrary loan) about 7 percent of the time.

Attempts to use the various citation indexes involve yet another set of criteria, varying with the index used. For example, use of *Science Citation Index, Arts and Humanities Citation Index,* or *Social Sciences Citation Index* in printed form or online requires correct last name and initials. Efficient searching also requires a correct year, volume, and beginning page number. Recent reloadings of the latter two indexes online now permit retrieval by either author name or journal title. Thus, as long as the citation has either the author or the journal correct, there are no fatal errors. However, since most users normally search via the cited reference's author, it is fair to use author errors as one criterion: using author names, the search would fail about 15 percent of the time.

If the searcher is cautious, however, and unwilling to accept anything that is not clearly the desired item, all errors become important. This approach is not unreasonable, since the ISI indexes do not give any information about the cited item, other than its citation, and very little about the citing articles. Given a prolific author, it is not impossible that the same person would publish at least two items in the same journal within a year. In this case, the author, title of journal, and year would be the same, but either the volume or the page number could be legitimately different. Under this cautious approach, *any* citation error creates a problem. The 7,827 citations contained a total of 2,797 errors in 2,156 different citations, or about a 28 percent failure.

Given the rather large rate of error, especially in scientific publications usually supposed to be accurate, and the long-standing nature of the problem, some sort of explanation is in order. This explanation must consider two facets: first, why errors are made in the first place; second, why they are not discovered and corrected before publication.

One answer to the first question, common since at least the 1840s [34, pp. 601–11] and emphasized by Wolff in 1911 [26, p. vii], could be called the "complexity" or "lack of standardization" factor. In essence,

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the argument here is that, given the variety of formats for citation and the lack of any real agreement among journals or authors, the chance of misunderstanding is high. Differences in journal title abbreviation have been commonly noted as a particular source of error [35–38]. For example, "J" can stand for "journal" and for "jahrbuch"; "ann" can mean "annals," "annual," "annalen," "annales," and so on.

Mere rearrangement of citation elements can also pose problems. The writer may miscopy numbers, for example, in placing publication date directly following the author (at the beginning of the citation) after habitually listing the date after the volume (at the end of the citation string). Complaints about lack of uniformity are common in the literature, whether from authors or librarians. The current state of affairs may be seen in the bibliographic citation database, ProCite. While based on the American National Standards Institute "standard format," the current version of ProCite includes twenty-six other styles, each in fairly common use [39].

A similar set of explanations relates to language. Many of the examples of errors listed in the early articles are of this type. Berger [40], as early as 1913, noted that both general terms in an unfamiliar language and specifically technical terms could pose a problem. And, of course, the Uplavici error began with a German misunderstanding of Czech dialect. Garfield raises a related issue, combining language with lack of standardization, noting the variants in author names (such as DeWeid vs. Weid, de) across languages [41].

A third possible cause of errors is generalized difficulty in spelling, such as the tendency to invert vowel and number pairs, consistently mentioned all through the literature [14, 15, 40]. The considerable modern work on spelling errors in general is inconclusive but seems to indicate that longer collections of letters are more likely to contain errors (the "serial position effect") [42]. Related work on telephone numbers tends to verify this finding [43]. On the other hand, Pollock and Zamora's work with general text found the letter in the *third* position (regardless of length of word) was most likely to be erroneous [44]. Studying mistakes in computer entry of baptism records, Norton and his colleagues found errors varied by *field* rather than by position in a given word. Transcription errors were greatest where the information was unfamiliar (for example, godparents' surnames) and where the set of possible responses was very large (for example, there are more personal names than states) [45].

Thus, it would seem that citations, by their nature, tend to be error-prone. The real question then becomes, if this is true, and if this has been considered a problem for over a hundred years, why do they still appear with such frequency? A very common suggestion is that errors

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persist because the citers have not actually seen the original, thus perpetuating any error that might be made by one who has. Certainly, the long life of "Dr. Dysentery" may be explained in this way. There are many claims that this wholesale recopying of earlier reference lists is increasing. For example, one letter in *Nature* calls such behavior a "fundamental law" [46], while another in *Science* merely lists it as one of several common practices [47]. The claim that this is getting more common, while undocumented, is also made by Chargaff, who notes that such recopying results not only in inflating the citation rates of some authors but also eliminating others from the later literature entirely [48]. A 1982 survey of journal editors, by the way, found that 49 percent agreed with the statement "authors commonly cite works they have not read," while only 32 percent definitely disagreed [49, p. 71]. Actual practice, at least among Soviet scientists, suggests the extent of the problem: 32.5 percent of respondents to a 1981 survey readily admitted they cited from other citations, without having read the original document [50, p. 61].

Verification of these claims is difficult. After all, use of "reverse" citation tracking is a legitimate method of research, and cocitation analysis is based on the assumption that usual scientific behavior involves consistent use of the technique [6]. However, Robert Broadus was able to follow one citation path, due to a simple error in the original. Edward O. Wilson's *Sociobiology* [51], miscited two article titles. Of 148 papers that cited both Wilson and one or another of the articles, 23 percent made exactly the same error as did Wilson. Since there are many other reasons for making the errors noted, however, Broadus is willing to accuse only two articles of possibly lifting the footnotes whole [52].

An extension of this possible laziness into definite dishonesty is certainly possible, with a number of cases coming to mind. Among the most notorious is that of the psychologist Cyril Burt, a pioneer in IQ testing. Posthumously, it was found that he not only had faked experimental data but also had buttressed his claims with references to nonexistent papers by (apparently) nonexistent people [53]. The most important point for our purposes is that both types of fraud were discovered only years after they were perpetrated. Where, forsooth, were the careful scholars reading the documentary proofs in Burt's papers all this time? Another example is that of Zoltan J. Lucas, who cited nonexistent papers of his own (some rejected for publication) in National Institutes of Health (NIH) grant applications. His excuse: he planned to publish but became too busy [53, pp. 104–10].

While these cases are extreme, it appears that a form of petty dishonesty is common in scholarly publishing. Many reputable authors appear to play a version of the "citation game"—where such purposes as pay-

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ment of an intellectual debt, attempts to increase one's own visibility, and the like replace the more accepted purposes of citation [47, 54]. Under these circumstances, accuracy can hardly be expected.

The perpetuation of gross inaccuracies suggests that the role of citations is not taken very seriously by the scientific community. For example, the nonexistent references in Burt's works would have been identified much earlier had his critics seriously attempted to read them. Blaise Cronin's survey of journal editors indicates a general feeling that the situation could be better: 65 percent of those responding agreed (7 percent strongly) that "journal editors and referees could pay greater attention to the quality and quantity of references" [49, p. 71].

An interesting case study of such attitudes appeared in 1982–83 regarding the journals of the American Society for Microbiology (ASM). An author claimed plagiarism by an article that had failed to cite his (and others') work. The ASM agreed that the citations should have been made but initially refused even to publish a letter on the subject, on the grounds that "there was an error of omission without malice or dishonesty" [55, p. 186], until considerable pressure had been applied. Interestingly, much of the comment from both authors and editors in this case argued the *referees* were responsible for checking references [56, 57].

Perhaps the most telling example of passing the buck appeared in a recent issue of *College & Research Libraries*. The authors claim that "it appears to the verifier that *almost all* of the citations are already correct when submitted" (emphasis added) [58, p. 494], and thus the requesting library should not be required to verify interlibrary loan requests. However, of 618 requests studied, 110 could not be verified at all and 242 contained errors or missing data. Thus, 57 percent were problematic in some way. Since the authors were concerned only with retrieval of a document in a library which owned it, they established a set of "minimal elements" needed to find an item: author's last name or article title, journal title, volume, and beginning page number. Using this very limited definition of correctness, they still found forty-five citations in error [58]. An error rate of 7 percent plus a "can't verify" rate of 18 percent do not seem to support the complacency of the authors.

This lack of interest in accuracy of citations may be related to a general lack of training in the norms and purposes of the bibliographic citation. Cronin found journal editors agreed (55 percent) that "the norms of citation practice are implicit" and (87 percent) that "citation is not a process which can be wholly rule-governed" [49, p. 71]. Voverene's scientists, while strongly agreeing on the importance of citations, had little formal training in them. Over 35 percent stated they had no systematic knowledge of the "ethical standards" of citation, while nearly

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42 percent credited only their own reading for such knowledge [50, p. 62].

Studies of style manuals aimed at thesis and dissertation writers provide further evidence that training in citation is poor. Of the forty-seven manuals examined by De Amorim, for example, only sixteen gave any quality criteria for citation, and only three listed accuracy as one of these [59, p. 73]. Only thirty-one of the manuals gave explicit reasons for citations and, of these, only fourteen included some version of "be helpful to the reader" [59, p. 26]. The extent of the problem may be gauged by De Amorim's finding that two of the nine manuals in scientific/technical fields did not even use examples from the sciences. Thus, the examples supposedly illustrating the rules for citation were themselves misleading [59, pp. 34–35]. Similar problems with miscitations, incorrect abbreviations, and confusing terminology related to government publications have been found in Kate Turabian's manual, *The Chicago Manual of Style,* and the "Bluebook" (*A Uniform System of Citation*) used by lawyers [60].

* * *

The situation 130 years after Verneuil's complaint has, if anything, worsened. The rate of errors in citations in respected scientific journals is high. While some complaints are routinely made, there is little consensus even as to who is responsible for correcting citations. Publishers seem to feel it is up to the author(s) to provide correct citations; the authors seem to feel it is up to referees to doublecheck them; no one, except perhaps librarians, seems to care very much about the problem. The quality of the texts for training new researchers in citation is poor, and there appears to be little training.

The solution to the continuing problem lies in two approaches. First, all those who assist researchers of any kind in obtaining documents owe it to themselves as well as the community of scholars to emphasize the serious consequences of apparently trivial errors. The current interest in improving the quality of research journals, now emphasizing the facts presented in the text of research reports [61], should be expanded to include the documentation for those facts. It has been argued that there is no effective way to check up on the details of research, even in the laboratory, without impeding the process of that research. Perhaps more attention to the easily checked references would provide one acceptable measure of overall quality.

A second approach must be the improvement of training of researchers, including those in the library and information sciences. There may be good arguments for a proliferation of citation styles. But, regardless

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of specific format, there are at least some general norms applicable to all styles [3, 4, 62]. All style manuals and "research guides," not to mention basic research methods courses, should include some discussion of these norms and of the reasoning behind them, not merely the prescriptive rules of a given style. In this process, it would be well for the information profession to put its own house in order. We spend considerable time and effort in training catalogers in both the theory and the methods of descriptive cataloging. It would be well to expend at least some effort on training all information workers in the theory and methods of the citation.

After all, we have at least one norm which few librarians would contest: Ranganathan's Fourth Law of Librarianship: "Save the time of the reader" [63].

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