

Current Comments®

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Journal Editors Awaken to the Impact of Citation Errors. How We Control Them at ISI

Number 41

October 8, 1990

The problem of inaccurate citations is considered. Studies investigating the incidence and variety of citation errors in various specialty journals are examined. Such errors include inaccuracies in bibliographic information as well as erroneous or inappropriate quotation of source material. ISI®'s quality-control procedures, designed to catch and correct citation errors as data are processed, are also discussed.

Introduction: The Problem of Verification

A major function in any research library is verification. Verification is required for document delivery (interlibrary loan) and for documentation of sources cited in manuscripts. Accuracy in citations affects both of these activities significantly. For references found in *Current Contents*® (CC®), accuracy is better than 99 percent, if you eliminate possible minor differences in article titles listed in contents pages and those in actual articles (ISI®'s data-entry "cataloguers" work directly from the original journal article). By double-entry verification, we achieve better than 99 percent "accuracy." This term is subject to many interpretations, since the treatment of special characters and symbols and the author's name is subject to many variations.

Since the ISI system for CC is integrated with that for the *Science Citation Index*® (SCI®), the same is generally true for the *SCI Source Index*. However, I regularly see allusions to the *SCI* that do not distinguish the two primary author indexes it contains. One, as I've mentioned, is the *Source author index*. The other is the author *Citation Index*. The 99 percent figure certainly applies to the *Source Index*, the ultimate verification tool. From 1945 onward we have in-

cluded over 12 million papers and other items in the *SCI*. The late scientometrician Derek J. de Solla Price, Yale University, New Haven, Connecticut, used to say that 90 percent of the scientists who ever lived are still alive. The *SCI* probably now covers 80 to 90 percent of the extant literature. If this statement isn't entirely accurate for the *Source Index*, it certainly is for the *Citation Index*. Having processed over 150 million references to date, of which at least a third are unique, the number of items that have escaped citation is relatively small.

All Authors?

A common misconception of the *SCI* is that it doesn't include all authors. Untrue. The *Source Index* covers well over 99 percent of author names—even those absurd team entries with over 100 names. It is the *Citation Index* that lists entries only by first author. I have often wished we had opted for less source coverage so we could include "all" authors named in cited references. For reasons too numerous to list here, that would have been counterproductive. However, with the advent of cheaper mass memories, we may soon overcome that limitation. ISI's in-house science indicators files do include all authors. Hopefully we will offer these

data in our future CD-ROM editions.¹ I have used such files for studies of most-cited authors.

The all-author question is relevant to a discussion of accuracy. As the following essay documents, errors of all kinds creep into the journals. Not the least of these is the misspelling and/or transposition of authors' names. Who knows how often Smith and Jones have been cited as Jones and Smith? In any case, whatever the figure, diligent librarians have usually been able to unravel these kinds of "errors" at least for document delivery. Ideally authors would consult original documents before citing them. As indicated below, the *New England Journal of Medicine* and other leading journals expend a lot of energy verifying references from the original. What percentage of entries in the *Citation Index* contain errors, no one knows for sure. If the number was significant, I believe we could not have survived 30 years of publication. Is it reducible? Yes—but at what cost?

The responsibility for these cumulated sins of the scientific community somehow falls to us because we have made certain claims for the value of citation indexes for information retrieval. I've not discussed this fundamental problem for some time in a *CC* essay. The *SCI* has been around for so long that we take for granted that informed readers know how to use it for its original intended purpose. However, as I lecture around the world I quickly realize that at least half my audience has never used the *SCI*—that this is a problem of continuing education. Only a small percentage of senior scientists provide instruction in these matters to their younger associates. And most librarians do not have adequate time for bibliographic instruction. That's why ISI has a staff of lecturers for this purpose.

All this notwithstanding, the errors in the literature can affect retrieval of pertinent information. But fortunately these random errors are overcome through redundancies. The average paper in molecular biology today cites 35 sources. If a misspelled name

or error in pagination in one citation causes a failure to retrieve, it is quite likely that the citing paper will surface under another *SCI* entry for the same author or another author or through other links, such as the *Related Records* feature on our CD-ROM products.¹ Indeed, were it not for the relatively high degree of accuracy in most citations, we could not extract keywords for the *KeyWords Plus*SM feature that is now part of *Current Contents on Diskette*[®] (*CC-on-Diskette*[™]).²

Bibliographic Injustice

These are all anecdotal observations on my part and do not lessen my concern for the occasional author who suffers from chronic misspellings or alphabetic disorder. But regularly publicized pleas for examples of bibliometric injustice do not evoke much response in our readers. In this essay we discuss a case where the recurrent omission of a single letter from an author's name was enough to measurably affect a paper's citation rate. Surely this author is not alone in having suffered this indirect lack of recognition. I'm certain that there must be others and often wish they realized we can correct many of these errors in the *SCI* files once we are made aware of them.

While we may overlook an occasional putative *Citation Classic*[®] by virtue of bibliographic injustice or the citation "amnesia" displayed by authors who "forget" to cite pertinent sources (more about this later), I doubt that anyone of Nobel class has been so victimized. If we had not stopped at listing the 1,000 most-cited authors of 1965-1978, would 2,000 have been enough? I still look forward to my magnum opus—a book on the 5,000 most-cited authors of the past four decades. But even that work will not satisfy those who believe that premature discovery is rampant and that latter-day Mendels abound who will not be revealed by citation ranking.³

However much we seek perfection in matters bibliographic, we can only approach

nirvana—but never reach there; it's a kind of bibliographic uncertainty principle.

Citation Errors—An Old Problem

In a 1989 review of errors in bibliographic citations, James H. Sweetland, School of Library and Information Science, University of Milwaukee, Wisconsin, recounted the strange tale of the author "Dr. O. Uplavici." In 1887 a medical authority named Jaroslav Hlava published an important paper on the role of amoebas in dysentery. The paper, written in Czech and titled "O Uplavici" ("On dysentery"), was later abstracted in the German journal *Centralblatt für Bacteriologie und Parasitenkunde*. Unfortunately, the journal omitted Hlava's name and entered the item under its Czech title. Subsequently, this mistake was repeated and compounded in various ways until 1910, when the paper appeared in the *Index-Catalogue of Medical and Veterinary Zoology*. The "author," O. Uplavici, was listed with a doctorate. The paper continued to be miscited until the error was discovered in 1938.⁴ I first heard this classic story when I joined the Welch Medical Library, Johns Hopkins University, Baltimore, Maryland, in 1951.

While most errors in citations may not be this extreme or enduring, the problem of incorrect bibliographic citations persists in many forms. Obviously, as one who has made a career of collecting, organizing, and analyzing citations, I have a particularly keen interest in this topic. In previous essays we have looked at various aspects of citation errors—discussing them in general terms⁵ as well as examining the complexities involved in processing surnames⁶ and the problem of omitting explicit citations to errors in textbooks.⁷ We have also examined the quality-control procedures that ISI has set up to catch and correct citation irregularities before they make their way into our database.⁸ In this essay we'll look at some of the different kinds of citation errors and examine studies from various subject specialties. And we'll provide an update on ISI's quality-control operations.

A Problem for Researchers and Librarians Alike

As Janell Rudolph and Deborah Brackstone, librarians at Memphis State University, Tennessee, recently pointed out in a guest editorial in the *Chronicle of Higher Education*, faculty members and students show little interest in citation errors until an inaccurate reference impedes their own work.⁹ The errors encountered on a daily basis by Rudolph and Brackstone, however, have led them to decry the "rampant" carelessness displayed by many scholars in citing sources. Documents or sources that are particularly problematic in giving rise to erroneous or incomplete citations include oral communications (something jotted down at a conference, for example); personal or departmental databases; the reference list in a book or journal from which citations may be copied with no effort to check the original source; and respected authorities whose work may be cited in the most fragmentary way—" (Jones, 1985)," for example—by authors who assume that everyone shares their familiarity with a given field's literature. Verification, according to Rudolph and Brackstone, should be the first principle of scholarship.⁹

Lack of verification, however, seems to be a continuing problem. In a 1983 paper, Robert N. Broadus, School of Library Science, University of North Carolina, Chapel Hill, devised an experiment to test whether authors copy references from other publications without checking the original sources, as some critics have charged. Broadus employed a 1975 textbook on sociobiology that included among its own references an erroneous citation to a 1964 article (one word was incorrectly substituted in the title). Examining the 148 subsequent papers that cited both the book and the article, Broadus could see how many authors repeated the book's mistaken citation. He found that 23 percent of the citing authors also listed the faulty title. Mentioning certain mitigating evidence, Broadus did not suggest that all these authors

had knowingly and unethically padded their own bibliographies without checking the original items. He did allow, however, that if only a small percentage of authors resort to such practices, it poses a significant problem for scholars engaging in certain kinds of citation studies.¹⁰

In a 1989 study, H.F. Moed and M. Vriens, LISBON Institute, University of Leiden, The Netherlands, employed data from SCISEARCH®, the online version of the *SCI*, to examine discrepancies between 4,500 papers from five scientific journals and some 25,000 articles that cited these papers. They found that 9.4 percent of the citations in the cited-reference data set showed a discrepancy in at least one field, such as title, author name, or page number. The majority of errors or variations existed in the original text and were not due to any subsequent processing. Moed and Vriens concluded that one cause for the multiplication of errors seemed to be authors copying erroneous references from other articles.¹¹

Citation Errors in Specialty Journals

Other studies have looked at the incidence and variety of citation errors in the literature of different subject fields. In one such study, Gerald de Lacey, University of Auckland Medical School, New Zealand, and colleagues examined the accuracy of quotations and references in medical journals. The authors selected references at random from the first issues published in 1984 of the *British Medical Journal*, *Lancet*, the *New England Journal of Medicine*, *Clinical Radiology*, the *British Journal of Surgery*, and the *British Journal of Hospital Medicine*. The authors then checked the original sources to see how accurately the material had been quoted and if the citations contained the correct bibliographic information. They noted that the original author was misquoted in 15 percent of all references and that most of those errors would have misled readers. Furthermore, nearly a quarter of the references contained at least one mistake, and

8 percent of these were judged serious enough to prevent retrieval of the article. Suggesting ways to "stimulate authors to be more accurate," the authors noted that journals might include a "Misquotations" column in which erroneous quotes might be prominently featured and corrected.¹²

A similar study was performed in 1987 by Phillip Eichorn, then a medical student at the University of Massachusetts Medical School, Worcester, under the direction of Alfred Yankauer, of the university's Department of Family and Community Medicine. Selecting references from three public health journals, they noted that 31 percent of the 150 references contained bibliographic errors, 1 out of 10 containing an error that would prevent the retrieval of the paper. As for accuracy of quotations, Eichorn and Yankauer found that 30 percent of the papers erred in quoting the original article; half of these were judged serious—that is, the material cited did not substantiate or was unrelated to the citing author's assertions.¹³

Yankauer performed a follow-up study in 1987, using reference lists from papers that appeared in the *American Journal of Public Health*, of which he is editor. Using MEDLINE and the *SCI* to check the occurrence of errors in nearly 600 references, Yankauer found that about a quarter contained one or more errors in author name, volume, year, pages, and the like. Of the 47 articles from which he had selected references, only one was entirely free of citation error. By way of suggesting remedies, Yankauer noted that the information sent to all prospective authors and reviewers of the *American Journal of Public Health* now includes specific instructions on checking original sources when compiling reference lists. The response has been encouraging.¹⁴

An even more intriguing recommendation was offered by James T. Evans, Nassau County Medical Center, East Meadow, New York, and colleagues. They studied the accuracy of quotations and citations in three surgical journals: the *American Journal of*

Surgery, Surgery, Gynecology and Obstetrics; and *Surgery*. Selecting one 1987 issue of each journal, the authors randomly selected and checked 50 references per issue. They found 13 major and 41 minor citation errors among the three journals. Examining the accuracy of quotations, the authors found 37 instances in which there was a serious discrepancy between the source being cited and its use in the citing article. In some cases, for example, the cited material was discovered to contradict the statements it was intended to support.¹⁵

Based on their analyses, Evans and colleagues expressed doubt that some of the citing authors had even read the original references, let alone verified them. Evidence seemed to indicate that the references had simply been copied from other articles, textbooks, or online databases. The authors noted that changes in the peer review system might be called for, with the addition of "citational and quotational consultants" to help enforce accuracy.¹⁵

In an editorial in *Ophthalmology*, editor-in-chief Paul R. Lichter points out that his own journal employs a reference librarian whose task it is to check each reference at its source. Lichter also briefly describes a survey in which he and his staff examined errors in four medical journals. As might be expected, the two journals that made a practice of checking all original sources had error rates substantially below those that didn't. However, as Lichter observes, the cost to journals of providing such accuracy can be significant. It is a cost that not every journal can afford. If all authors recorded their references correctly, he concludes, "journals seeking perfection in their bibliographic content would not have to devote so many resources to this task."¹⁶

Some years ago my colleague Henry Small, director, Corporate Research Department, and I informally discussed the idea of what might be called a "National Citation Facility." This online database of citations would afford instantaneous access to authors who wanted to verify their references. Al-

though our idea never got beyond the talking stage, I believe that, ideally, future authors should be able to go online or use CD-ROM to check references in real time.

For the present, however, studies from other subject fields have also pointed to a disconcerting prevalence of errors. For example, Carol A. Doms, School of Dentistry Library, University of Missouri, Kansas City, examined five national dental journals, selecting and verifying 100 references from each. Doms found that, of these 500 references, nearly half contained inaccuracies. Seventy percent of the incorrect group were judged to contain minor errors in title, author, and other bibliographic details. The other 30 percent were classified as containing major errors. Of these, some contained an incorrect journal citation while others featured erroneous author or title information; still others simply could not be verified.¹⁷

A selection of analytical chemistry journals was examined by Tibor Braun, Institute of Inorganic and Analytical Chemistry, L. Eötvös University, Budapest, Hungary, and Andrea Palos, Library of the Hungarian Academy of Science, Budapest. Examining 150-200 references from each of nine analytical chemistry journals, the authors found that the percentage of references containing errors varied from journal to journal—from 0.7 to 6.6. While observing that the error rates seemed to be less than those found in some studies—such as de Lacey and colleagues¹²—Braun and Palos noted that the author's responsibility of providing accurate references seemed to be neglected all too often.¹⁸

Paul F. Neihouse, Marion Laboratories, Kansas City, Missouri, and Susan C. Priske, University of Missouri, Kansas City, looked at the accuracy of referenced statements in four peer-reviewed, pharmacy-oriented journals. Using review articles on drug therapy published during 1987, the authors selected 99 references. After checking the statements attributed to these references against the original sources, the authors

determined that 31 percent of the references had been inappropriately cited.¹⁹

In their discussion Neihouse and Priske concede that deciding whether or not a reference has been appropriately cited may be a somewhat subjective judgment. While acknowledging the possible introduction of bias or incorrect interpretation of results in their study, they express confidence in their findings. They conclude by calling for greater vigilance on the part of authors and during the editorial review process.¹⁹

The methodological caveats raised by Neihouse and Priske could, conceivably, apply to any of the foregoing studies, given that most involved subjective evaluations of "minor" or "serious" errors. However, the studies undeniably point to a pervasive and troubling problem. I can only reiterate what most of these researchers have concluded: that the burden is on the author to consult and cite *original* articles and books, rather than resorting to copying them wholesale from other sources. Authors must also take pains to see that the material they quote from other sources is reflected accurately in their own work. And, of course, they must provide complete, verified bibliographic information for all cited material.

It is worth pointing out to *all* authors that the perpetuation of sloppiness or inaccuracy in citations could conceivably have the consequence of preventing their *own work* from being retrieved, consulted, and duly recognized. In other words, if you spell my name wrong, you may cause someone to miss your paper. Errors, as we'll see, can also have a measurable effect on a paper's citation rate. Obviously, it behooves all authors to hold themselves to the most stringent standards of accuracy.

At ISI, we are fortunate in that we can do more than exhort authors to be accurate. In many cases, we can actually correct inaccurate or erroneous citations. Of course, we are by no means immune to committing errors ourselves. Given the volume of material that we process, it is virtually inevitable. Such a disclosure, as I observed in our 1974

essay on errors, might contradict Napoleon's recommendation that one "wash one's dirty linen at home."⁵ However, as I professed then, I believe that ISI enjoys a special relationship with the readers of *CC*.

Quality Control at ISI

In a 1983 essay, as noted earlier, we examined ISI's quality-control procedures, explaining how we attempt to catch errors in the thousands of articles that ISI processes *per day*.⁸ Today, the number is something like 40,000 cited references from about 3,800 source articles. The procedures described in that essay are still utilized to detect and eliminate errors in ISI's database and products.

One example is the *Keysave* program employed in our journal processing. This procedure makes use of a 14-character code for each article, incorporating the first four letters of the first author's name, the year of publication, and the volume and page of the journal in which it appeared. The data-entry operators key in the code for every "promising" citation they process. If the computer recognizes this abbreviated citation and matches it with a verified reference already in the database, it sends a signal to the data-entry operator. Only if there is no match must the entire citation be keyed. This system, as was explained in a previous essay, has the advantage of saving labor as well as correcting citations.²⁰

We also apply the "Forever File," which contains accurate records on over eight million articles. In preparing our annual citation indexes and cumulations, we run all citations processed during the year against millions of source articles stored in the Forever File. The computer condenses each citation into a 14-character code and then searches the file for the source article matching this abbreviated citation. When a match is found, the computer confirms and/or adjusts the reference and rewrites the new citation to conform to the bibliographic information in the Forever File. In this way, any

errors that appeared in the current citation, such as a misspelling beyond the first four letters of an author's name or an error in the name of the cited journal, can be corrected.

In the latest installment of our series on the most-cited papers in the *SCI*, 1945 to 1988,²¹ we noted that a recurrent spelling error had substantially affected the citation count of a 1982 *Gene* paper by Jeffrey Vieira and Joachim Messing, University of Minnesota, St. Paul, concerning pUC plasmids.²² The paper was incorrectly cited under the name "Viera J" more than 350 times. As the misspellings occurred *within* the first four letters of the first author's name, our system did not unify the erroneous citations. In all our quality-control operations, efforts to provide accuracy and make corrections must be balanced against the danger of actually *causing* errors by unifying citations that should be kept separate. In this case, the computer judged that names beginning with "Vier" and "Viei" are distinct enough to remain separate.

Fortunately, when a recurrent spelling error like this is discovered in our database, we can go in manually and change the code for the incorrect spelling so that all future misspelled citations will automatically be linked to the correct reference. In this case, all subsequent citation errors of this type will be corrected.

For the annual editions of our citation indexes, and for the five-year cumulations, another level of unification takes place. This level is designed to correct errors in the volume or year of cited journal references. The computer will evaluate variants in the volume number or year for a given citation. If a "consensus" can be reached based on reliable information in the dictionary, and if there are no other discrepancies besides the volume or year in the citation—that is, one or the other must be correct, along with all other information—then the computer will correct the error and unify the citation.

This can be illustrated with a 1987 article that we identified in a previous essay as

that year's most highly cited physical sciences paper, based on 1987 and 1988 citations.²³ The paper is by M.K. Wu and P.H. Hor, who each led teams of colleagues at the University of Alabama, Huntsville, and the University of Houston, Texas, respectively. This article, which appeared in *Physical Review Letters*, discusses "Superconductivity at 93 K in a new mixed-phase Y-Ba-Cu-O compound system at ambient pressure."²⁴

Checking a brief sampling of 1990 citations to this paper on *SCISEARCH* revealed a variety of errors culled from various publications. While most authors recorded the correct citation, a few came up with apparent discrepancies: the year of publication misidentified as 1988 or 1989, the volume number off by 50, the page number off by more than 400.

As it happens, there is very little time to perform any kind of quality control on the data placed online through *SCISEARCH*; as a result, such original errors do occasionally slip through. However, the higher level unification performed on data compiled for annual and five-year cumulative editions *would* catch the discrepancies in volume and year, and all would be unified under the proper citation. In the case of a discrepancy in page numbers, we do not unify citations. While a variation in starting page may in fact be an error, it is also not uncommon for authors to publish more than one article in a given volume. This is another instance where we do not want to risk *initiating* a mistake.

Today, a major focus of our quality control effort involves eliminating original errors in citations in articles processed for our current-awareness products, such as the weekly *CC-on-Diskette*,³ *Research Alert*[™],²⁵ and *Focus On: Global Change*[™].²⁶ Although the deadlines for these products still make it impractical to perform every last vestige of checking and unification of data, we are taking steps to verify and correct material "up front" as much as possible.

Data are now built into a new database structure using a package known as

ADABAS. Our unification procedures assign all unique cited references into one of two files: certified and uncertified. The certified references are those that appear to be accurate on the basis of their presence in our source data or because of their repeated appearance in the same form. Through an automatic "self-cleaning" procedure, the certified file is modified as more and more citations to the same articles are accumulated. Variants are cleared up as the system evaluates and "recognizes" the standard form for repeated references. Both the certified and uncertified files are periodically reexamined, and uncertified data can become certified. Similarly, certified material is occasionally decertified as newer information renders the old data questionable—as in the case of Vieira/Viera. The most flagrant discrepancies are checked by hand.

Unifying Book Citations

At the end of last year, we also added a new correction-adjustment system to unify citations to most books. The system employs an advanced version of Soundex, the system used in airline reservations. Since book citations typically do not have volume numbers and often don't cite page numbers, the system employs a different "quintessence" from the 14-character code used to process cited journal articles. The Soundex system creates a code for authors' last names using the consonant sounds of the last name. ISI's upgraded Soundex system even enables us to recognize most variants in Cyrillic and Chinese names. For example, Tchaikovsky, Chaikovsky, and Tchaikovski—or Hsin, Sin, and Xin—can be unified. A code is also created for the book title. This is based on the observation that books are usually cited by their full titles, rather than the abbreviations commonly used to cite journals.

As with those journal references that we have been able to verify definitively, we have placed known books into a dictionary that can be used to verify and correct subsequent book references. This dictionary

features a quintessence search key and preferred titles for each book.

To Err Bibliographically Is Human

Obviously, authors will continue to make errors in citations, and we will continue to see such mistakes as we process data at ISI. The problem of citation errors—of inaccuracy in both bibliographic information and the quotation of source material—seems serious indeed.

In this essay we have not discussed citation practices that—in contrast to the typographical errors and general carelessness discussed here—are patently unethical. One of these practices involves referring to an idea or concept that the author may have heard of or seen somewhere without attempting to credit the original source. This "citation amnesia," as we termed it in a 1982 essay,²⁷ is no less serious a problem than the errors we've discussed. In fact, as it clearly borders on more extreme forms of intellectual dishonesty, such as outright plagiarism, citation amnesia is probably far more serious. Like some of the errors examined in this essay, it can have the effect of preventing the retrieval and recognition of deserving work and disrupting the reward system of scientific publication in which citations are the major "currency."

Some of the remedies mentioned here, such as the use of citation consultants, are worthy of further study. However, the primary responsibility for accuracy and completeness in citations must reside with authors, as well as with editors and publishers. Clearly, it is a responsibility that has significant ramifications for the basic integrity of the scientific literature.

* * * * *

My thanks to Christopher King, Judith E. Schaeffer, and Irv Sher for their help in the preparation of this essay.

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