Scientific Publishing

Part I: What is a scientific publication?

by Frank Gollnick

Quite often media sensationalize scientific studies producing alarming "scientific knowledge", thereby raising concern in the broader public. But did study results really meet scientific and methodological criteria and, or have they been verified? These questions are crucial.

... The aim of this study was therefore to find out whether people living in the vicinity of mobile radio base stations are exposed to an increased risk to develop malignant tumors. The data basis of the study was computerized patient records of health insurances from the years 1994 to 2004. The study, performed without external support, included data of nearly 1000 patients from the town Naila (Upper Franconia, Germany); the requirements of data protection were met. The result shows that the percentage of new cases of cancer significantly grew over the past ten years in persons living at a distance of up to 400 meters to the mobile radio station operating since 1993, compared to patients living farther away, and that patients were younger at onset of the disease."

Who can say whether the alarming study published by Horst Eger as an "original scientific paper" in the journal "Umwelt, Medizin, Gesellschaft" ("Environment, Medical Science, Society [1], from which the quote is taken, is scientifically valid? It is very difficult for laypersons not involved in science to answer this question. The term "original scientific publication" per se suggests that it has been scientifically acknowledged. Nowadays, articles published in German health insurance member journals are scarcely distinguishable in their layout and language from scientific articles in "authentic" (German-language) scientific journals. The presented example was not taken from a health insurance journal, but from more than nothing the journal of an association composed of several societies (among others, the IGUMED, an association of environmental medicine professionals, scientists, building biologists, jurists, etc., the "Interdisciplinary Society for Environmental Medicine") – more or less comparable to the FGF Newsletter you are holding in your hands or reading from the screen. No scientist would think of characterizing our articles as "original scientific publications". But what does

the term "original scientific publication" mean? Are there any qualifying criteria?

Yes, there are criteria at least facilitating orientation in the "jungle" of scientific publications. This article (in its first part) attempts to give more detailed information on how classification of scientific relevance of publications is done, about the process of scientific publishing and how to identify scientifically relevant printed information. There is some confusion, both among normal people interested in science and in media, over scientific research results and their acceptance within the scientific community, what results are commonly acknowledged and why.

How do scientists publish their results?

After completion of a scientific study, every researcher wants resp. has to disseminate his results to his colleagues so they will be acknowledged by the respective part of the so-called scientific community. Here public discussion of his results takes place. Depending on their relevance, his reputation in the community will grow, and he will become known as an expert in a certain field – unless he changes disciplines quite frequently. Conditions are somewhat different in the area of commissioned or industry research, where results often are not (resp. not at once) meant to become part of public discussion, but are used for obtaining patents (e.g. pharmaceutical research, synthesis of new active ingredients, matters or devices, etc.). Nevertheless, for the most part, results later on make their entrance into *scientific literature*. In medicine, research often goes hand in hand with patient care – a research field with its own rules for publishing scientific observations: commissioned pharmaceutical research, single case studies, screening studies, to name but a few. There is a separate branch of scientific medical literature responding to other needs than the rest of natural sciences.

Over time, the scientist learns that there is a smaller number of scientific journals out of thousands of publications that are most appropriate for publishing his results. Worldwide, there are about 250,000 journals and other periodicals (e.g. newspapers) listed for libraries, among them about 20,000 journals in nature science. Based on criteria I will describe later on, the researcher selects a journal, provide himself with the guidelines for publishing in this journal (details differ across publications) and then submits a duly prepared *manuscript for publication* to the editors. It is not allowed to submit results to several scientific journals at the same time. Neither is the publication of the same results successively in several journals compatible with the basic principles of scientific publishing, even though some try to ignore this rule by using certain tricks. Submitting a manuscript to different scientific journals is permitted only when it has been *rejected* by the selected journal (this happens quite often). Reputable scholarly journals accept only one manuscript out of five, or even one out of ten, for publication, since they are flooded with manuscripts and thus can freely pick which one to use. In the case of rejection a manuscript can be again submitted to another scientific journal (after revision according to its guidelines). Often, the scientific ranking of the second or third journal chosen for submission is lower. In principle, this can be repeated as often as one likes; the only limitation arises from the work that is to be done by the scientist to adjust the manuscript to the respective guidelines. Overall, this promotes selection, from the perspective of science (however, as a matter of course subjective preferences of the journals' editors unfortunately play a considerable role in this - see below).

In spite of this, if the scientist is determined enough, practically *any* scientific result can be published in *some* journal – almost regardless of the quality. He/she would only have to adhere to the formal rules of the respective journal and meet some minimum requirments, if less renowned journals are selected for the publication of results. However, general acceptance of the published results' scientific relevance

decreases with the "exotism" (i.e. lower scientific relevance) of the journal, which will finally print the manuscript. "Exotic" here means "less noticed or read"; however, a difference must be made between scientifically irrelevant, but widely spread, much read pharmacy and health insurance trade magazines, and the "exotics" among scientific journals that are less read by scientists (or only by a very small group of scientists), but scientifically acknowledged. I will get back to this later on. Anyhow, when assessing the value of published research results, we have to look at the journal *where* it was published. To draw a more complete picture, some further terms have to be defined.

The peer review process

What is it that makes a journal with scientific content "scientifically relevant" or "scientifically less relevant or irrelevant"? The question is: What makes a scientifically worded publication an "original publication", i.e. the only kind of publication that is scientifically significant? There are two basic criteria that, albeit not absolutely valid and uncontroversial, are widely accepted, important indicators: the *peer review system* and the *impact factor*.

The so-called peer review process was established worldwide in the course of the 19th century by reputable scientific journals. The aim was to verify the quality of scientific results submitted for publication as carefully as possible. Only publications in scientific journals where authentic peer review is performed can nowadays be called "original publication" in science. The term "peer review" is related to "peer group", a term originating from sociology or psychology (e.g. behavioural orientation in children). "Peer" can also stand for critical scrutiny of equals, e.g. persons of equal scientific qualification, or persons from the same field. As "review" stands for assessment, looking over, verification, peer review is a process in which submitted manuscripts are scrutinized and (anonymously) assessed for the scientific journal by scientists who are active in the same or related fields. In practice, the "editor", i.e. the managing director or chief editor of a scholarly journal, usually sends a manuscript submitted to him/her (after prior verification of its basic suitability for this journal) to two or three, in his/her view, qualified persons from the group of reviewing scientists the journal has in its ranks (and who are mostly identified as a group of such) and gives them a few weeks time to scientifically validate the manuscript, based on their expertise in the field, and to finally write a short evaluation. This evaluation is often done according to a formalized criteria catalog. It is important that the reviewer is not part of the editorial staff. Only the editor knows the peer reviewers of a certain manuscript. If opinions are very controversial, sometimes-additional advice from an independent further expert is seeked. Often, the evaluations are closed by a recommendation is added on how to deal with the "request for publication". Based on the evaluations, the editor then decides whether a manuscript is "accepted without revision", "accepted with minor revision", "accepted after thorough revision", or "rejected". "Accepted after thorough revision" can mean that, in an extreme case, additional experiments must be performed, repeated, re-evaluated in whole or in part for final acceptance. This can easily take another six months of laboratory work. Remarks and questions of the reviewers can be very detailed. The researcher then can decide whether he or she thinks the additional time spent on the project is worthwhile, or whether the manuscript should be submitted to another journal (as indicated above, often of lower ranking).

In some cases, it is not so easy to see on first glance whether a journal is peer-reviewed. With regard to many highly reputable journals, scientists simply know that they perform peer-review processes. This is different for quite a large grey area where the contents of the journal are easier to comprehend for non-specialists or not published in English, where research

fields are "exotic" or do not conform to traditional science ("alternative science"), or where it is not clearly stated that a peer-reviewed gets performed. Every journal that claims to offer peer-reviewed information should publish its "Guidelines for authors" describing, amongst others, the applied methods of manuscript review in detail (e.g. the number of reviewers, use of their judgements, details of proceedings). Other information determining the peer-reviewed status of a journal are the inclusion into scientific databases such as PubMed **[2]** or in an "Impact factor" list I will later say more about.

An internationally valid, "official" list of peer-reviewed scientific journals does not exist though. The most reliable information is found in "Ulrich's International Periodicals Directory" **[3]**, the leading commercial database (as well in print version) for libraries listing all available journals and other print *periodicals* and online serial publications (i.e. also non-scientific publications). At present, the database contains about 250,000 periodicals. Approx. 10% of these (24,000) are characterized by a special symbol as "refereed", which is meant to say they are peer-reviewed. However, a random sample test showed that this characterization unfortunately is also used for non-scientific journals (e.g. a Berlin city magazine). Thus, to my knowledge there is no absolutely reliable survey of scientific press in this respect. When in doubt, you have to make inquiries at the respective journal itself regarding manuscript acceptance policy, and to decide on your own whether it conforms to the here described criteria of peer review. "No results" in the aforementioned database PubMed is a quite sure sign, at least in the field of *biomedical* publications, that it is not acknowledged as a peer-reviewed journal.

The Impact Factor

The second much-used criterion in science for the classification of relevance of a publication is the so-called "Impact Factor" (IF) which is determined every year by the American "Institute for Scientific Information" (ISI) for the last two years **[4]**. The factor relates to scientific journals, not to single articles. The yearly "Journal Citation Reports" of the ISI comprise more than 7500 scientific peer-reviewed journals from about 200 disciplines; "Science Edition" at present covers more than 6100 of the leading international scientific journals in the area of natural sciences **[5]**. In principle, the IF measures the frequency with which articles from a specific journal are cited in articles of other scientific journals, and this is always evaluated for a time period of two years. *"The impact factor is a simple quotient derived from three numbers. It refers to the number of publications that have appeared over a period of two years in a reputable scientific journal. The ratio between the number of citations within this time window and the number of published papers – that is the impact factor." ...*

"Today, about 50 years after its invention by Eugen Garfield in his Institute for Scientific Information (ISI), the index has phone book size of a big city, or is delivered on a CD-ROM to subscribers. Not all studies published in a journal contribute to the impact factor. Only reviews and original papers count. But sometimes also short communications, technical notes or reviewed casuistics are included in the ranking. The decision is up to the ISI. Meeting abstracts and letters to the editor are omitted. But every rule has its exceptions: If substantive research is suspected behind a short communication, this information only a paragraph in length can also be cited and contributes to the bloom of the impact factor." **[6]**

Regrettably, publication frequency of a journal and the number of articles per issue play a role in the simple calculation of the IF, thus considerably distorting the original intention of a factor meant to enable comparison between journals (cf. in **[7]**).

Correspondingly, the distribution of the IF offers a heterogeneous picture: Only relatively few, highly reputable journals (approx. 5% of those comprised by the ISI) with their IF are in the range between 4 and

52.58 (the highest presently – for 2003 – determined IF for the journal "Annual Review of Immunology"). The huge mass of journals is between IF 1 and IF 4, the main part of it between IF 1 and IF 2. Another, only slightly smaller group has an IF between 0 and 1. Here are the many journals which are seen as less relevant from a scientific point of view, but after all are made part of the IF lists (see also: **Table 1**). *"... Before a journal is given the quality label of the impact factor, i.e. it is listed, it has to merit inclusion in the Scientific Citation Index."* **[6]** All in all, there is an almost exponential distribution, with the mass of journals found in the lower IF range.

Limitations of scientific criteria

As mentioned above, the peer review process and the impact factor nowadays are controversially discussed. *"In this country the impact factor is career-promoting."* **[6]** In Germany, it is a criterion for habilitation and for the ranking in the academic area (e.g. in obtaining full professorship or when applying for public research funds) and thus is misused even in the view of his inventor. *"In a 1998 editorial, Eugen Garfield sharply criticized the German misuse of the impact factor for the ranking of personal achievements of researchers."* **[6]** This was obviously not what it was intended for, and its use is limited in this respect. Other limitations, such as subjective prejudice and the largely concentration of comparative parameters in the English-speaking region are in-depth depicted in the article several times quoted above by Victor Oehm and Udo Lindner from the "Deutsches Ärzteblatt" **[6]**. But they also say that the impact factor is well-established now and, at least by the Germans, is taken for granted in the ranking of scientists. Moreover, more objective criteria for evaluation were not really in sight. The fact that its founder, Eugene Garfield, sold his life' work, the Institute for Scientific Information, to the pharmaceutical company Thomson a few years ago, is indeed seen as a sign by Oehm and Lindner: *"This step was taken at precisely the right time, for the critique of the impact factor and the understanding of its limited use is growing."* **[6]** At least, a "revision" of the impact factor and its interpretation has begun, as is shown in an article of Matthew Cockerill published in a free online journal **[7]**. See there also the reference made to the large number of contributions of Eugene Garfield **[8]**.

Unfortunately, researchers not speaking English as their native language, nowadays are committed to publish their results in English-language scientific journals in order to be heard and taken seriously on an international level. Nobody is seriously recognized in the international scientific community who is not able to discuss his research results in English at international congresses. On the one hand, only the silent "agreement" on English as the (scientific) world language enables international discussion of global prob-

Scientific Journal	Impact Factor 2003
Annual review of immunology	52.280
Nature reviews. Cancer	33.954
Nature	30.979
Science	29.162
Cell	26.626
Lancet	18.316
Circulation	11.164
Radiation research	3.208
Brain research	2.474
Die Naturwissenschaften	1.883
Bioelectromagnetics	1.526
IEEE transactions on bio-medical engineering	1.398
International journal of environmental health research	0.588

Table 1: Examples of scientific journals with „Journal Impact Factor" 2003

lems or important research results. On the other hand, this is a huge advantage given to native speakers over non-native speakers that should not be underestimated. The effects have become quite obvious; and, in the author's opinion, this factor is often not sufficiently considered in the search for reasons behind the prevalence of American research versus other countries. The time advantage alone given to native speakers writing a scientific article should be considerable in today's increasingly competitive academic activity.

The second acknowledged criterion for the scientific character of publications, the peer review process, is controversial and not seen any longer as optimal. Whole conferences are devoted to this problem, examining limitations and looking for improvement and alternatives. The fifth international congress "Peer Review and Biomedical Publication" will be organized by the "American Medical Association" (AMA) in September 2005 in Chicago **[9]**. Papers submitted to the previous congress made clear that many problems are known and that *"... changes are necessary that would improve the ethical climate of the publication of research by making it both more open and more responsible."* Among other things, it is demanded

- that *"... peer review will become open, and we will come to talk about anonymous review as a quaint anachronism."* Moreover
- to make peer review more and more public, with the participation of readers **[10]**, and
- to let scientists "*take full responsibility for the aftercare of their papers*" (where necessary in the form of amendments, corrections, or even counter-statements based on more recent knowledge).

Successful attempts have already been made by reputable journals to involve interested readers and the interested public in the review process by using online media ("The reader as reviewer") **[11]**. One of the new ways to open up to the external world and to foster open participation in science is the ongoing establishment of a growing number of freely accessible or commercial pure online journals. A few years ago, this form of scientific communication was seen as more or less disreputable and difficult to control, the outskirts of scientific publishing, but it is now becoming more and more well accepted and even could be the future of a system that obviously needs reformation. Nowadays, only 2.5% of scientific articles published per year in the aforementioned 24,000 peer-reviewed journals are officially freely accessible online, as they are published in the about 600 peer-reviewed online journals now existing and offering free downloads. About three times as many (7.5%) articles are actually available for free on the Internet; they are posted on the homepages of many authors and can be downloaded. Many people have recognized that it is an obstacle to the lively exchange of scientific information if original papers are available only for high fees or in selected libraries.

Evaluation in the grey area

As was mentioned above, there are grey areas in scientific literature, on the one hand between real scientific journals and popular science publications; on the other hand within the range of real scientific journals, between reputable journals ("major scientific journals") and, so to say, "exotics" (minor scientific journals"). So, what is their scientific value, if research results are published in a journal pertaining to one of these grey areas? What about e.g. the many well-known magazines communicating knowledge such as "Scientific American", "Geo" and "P.M." in Germany or "National Geographic", which all are not listed with an impact factor in the ISI Science Citation Report?

In these cases it is actually relatively simple, because articles published there generally are a special kind of "review", a summary of research results published in several peer-reviewed original publications and prepared for readers with a general interest in science – i.e. not necessarily – but as well – for

experts. Articles published there do not claim to present every detail of the regarding research in a reproducible and comprehensible form, as should be the case in original publications. A similar case are the science pages of big national newspapers; for the most part, articles there refer to one particular, often new original publication printed mostly in a very high-ranking scientific journal (e.g. "Nature"). Peer review is not required for such science articles, since it has already been done for the socalled *primary literature*. Such articles should always include references to the original literature used. Knowledge magazines, scientific newspaper articles, and also genuine scientific reviews (summary of extracts from many original publications on a certain topic) are therefore so-called *secondary literature*. A second own peer review is required only in the case of scientific reviews; accordingly, scientific journals exclusively publishing reviews can be listed with an impact factor.

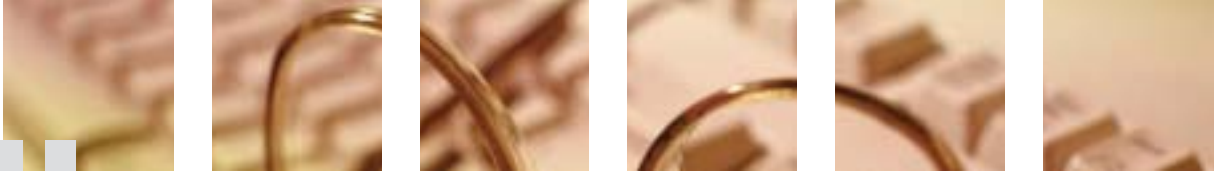
With regard to journals written in other languages than English and, unfortunately, also online publications it is more difficult to distinguish between real scientific journals adhering to the aforementioned criteria and those only taking the appearance of scientific journals (and this happens quite often; cf. **fig. 1**). But there are absolutely a few Japanese, Russian or German scientific journals which are peer-reviewed and are listed with an impact factor. While the German journal "Die Naturwissenschaften" e.g. is listed with a relatively good IF (at least for non-English-language journals; IF 1.883, i.e. "better" than the IF 1.526 of "Bioelectromagnetics"), the (in Germany) well-known "Naturwissenschaftliche Rundschau" is not listed at all, although – also internationally – renowned scientists publish there. However, both are listed in the database "PubMed". This might show that, when in doubt, different criteria (mentioned in this article) should be used to find out whether one deals with an accepted scientific journal containing – in the true sense of the word – "original publications". Journals of associations and organisations or societies, magazines and others will be ruled out in the course of this double-check validation procedure for original literature", even when articles conform to the usual structure of "original publications" – abstract, introduction, material and methods, results, discussion, references.

The "exotics" among genuine scientific journals listed far below an impact factor of 1, if at all, have shown to meet some minimum requirements for scientific journal publishing. However, the scientific relevance of submitted research is less regarded, and neither are the used quality standards, e.g. concerning the performance of experiments, their exact description, the technical equipment or the statistical evaluation of results. The scientist will find it relatively easy to publish his research results there: in most cases, the reliability of the described research is not verified with as much digilence and expert's competence as in renowned journals. Of course, there are exceptions. There are cases where results published in the high-ranking journal "Nature" had to be withdrawn after serious mistakes in the execution of experiments had been revealed. On the other hand, there will be a sufficient number of cases where research that is now seen as groundbreaking was rejected by high-ranking scientific journals and instead had to be published in an "exotic". But in general, the likelihood of finding *reliable* research results will be higher if they were not published in an "exotic" scientific journal – with all due limitations pointed out in this article.

Conclusion

There are criteria and tools allowing classification of printed scientific information to a certain extent. Available methods and indicators, however, must be reformed, at least in part, and absolute safety in the evaluation of research information is not ensured. After all there are certain useful tools which are partly under actual improvement and should be applied in combination in cases in doubt – above all, in the grey

Figure 1: Appearance of three articles taken from peer-reviewed journals listed with an impact factor (a-c), and the publication of Horst Eger et al. (d, [1]). The first page of each article is shown.



area between pure scientific and popularly processed information. Especially in the field of research on potential health effects of electromagnetic fields, a mass of insufficiently verified secured scientific (and also non-scientific) information is spreaded. Only experts from the respective areas of biomedical and technical research can cope with the task to distinguish substantial scientific knowledge from scientific-sounding factoids.

As accompanying measures the scientific exchange, has to be advanced at congresses in special workshops, and by personal contact, for it is here where reliable research results will withstand critical disclosed scrutiny by members of regarding "peer groups". Specialized *journalists* can only count on the assistance that is offered to them for classifying written scientific information. Those assisting tools, like open databases, have to be used thoroughly, but they also have to be improved, and access to them must be made easier. A comparison of *all* available original publications on a specific controversial scientific issue will be the only way to come to sound judgements, e.g. regarding health effects of some interaction investigated in research. On the contrary, by attending scientific lecture events alone one risks to become a victim of "science theatre" – if not being fully familiar with the subject matter. Thus, the system of scientific publishing based on peer review and the impact factor has still its worth, but should be more open and free from personal bias.

The 2nd part of this article: "Scientific (EMF) literature databases" will be published in the next issue of the FGF Newsletter.

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