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Title; Perspective Factor: A novel indicator for the assessment of journal quality

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Abstract

'Impact Factor (IF)' has practically been the only indicator to assess journal quality. However, it has a various problems associated with citation analysis, such as the effects of "different sizes of audience" and "biased citation". To overcome this dilemma, we here propose a new objective index, 'Perspective Factor (PF)', which estimates the journal quality independent of "citation analysis". The relationship between IF and PF of life science journals published in 1997, for example, gives a positive correlation when we excluded review journals and extremely high IF journals such as 'New Engl J Med', 'Cell', 'Nature' and 'Science', which could not gain comparatively high PF values.

1. Introduction

In modern society, individual research quality needs to be evaluated in terms of its scientific significance as well as its social benefits, including the resultant patents and social welfare. The quality of individual scientific research is usually believed to be represented by the rank of the journal that publishes the individual research results (Taubes, 1993; Vinkler, 1986). Therefore, objective evaluation of journal quality is important for such ranking.

'Impact Factor' (IF) based on so-called 'citation analysis' (Wade, 1975) has been the most well-known and indeed the only indicator to evaluate the journal quality (Brody, 1995; Cole and Cole, 1972; Garfield, 1955; Garfield, 1970; Garfield, 1972), however, there are concerns about the accuracy of reference citation, and suspicions of the impartiality of the citation analysis.

The effect of 'Biased Citation by authors' is one such problem (Kostoff, 1998; MacRoberts and MacRoberts, 1989; Reedijk, 1998; Seglen, 1997). First, since it is physically impossible for anyone to read all of the articles that are related to his/her research, one can cite only the articles he/she has read. Second, since the articles appearing in high IF journals tend to be favorably cited compared to those in low IF journals, even if they address the same issues with the same conclusions, and since the articles and/or journals from developed countries are believed to be more reliable than those from developing countries, citations can often be biased (Bordons, et al., 2002). Third, sometimes the editors of journals force authors to cite articles from their journals (Adam, 2002; Massie, 2002; Whitfield, et al., 2002). Therefore, in such cases, citations lack the fairness, and the IF values of journals cannot correctly represent the influence of the journals on scientific activities.

Another problem in citation analysis is the effect of 'the size of the journal audience’, as it possibly affects the IF estimation (Kostoff, 1998; MacRoberts and MacRoberts, 1989; Seglen, 1997). Articles in famous and mass-circulation journals of big disciplines are easier to cite than those in minor journals. The last problem is the 'review effect', which also influences citation analysis in the sense that secondary sources are easy to cite (Hecht, et al., 1998; Kostoff, 1998; MacRoberts and MacRoberts, 1989; Seglen, 1997).

Here, to overcome the shortcomings of IF and to consider journal quality from a different point of view, we propose a new indicator, the Perspective Factor, which evaluates the perspective of topics contained in journals independent of "citation analysis".

2. A novel indicator for journals perspectives

Almost all progress in science is affected by concepts derived from previous research activities. Therefore, it is worth evaluating the perspectives of the research that influences the following periods of research activities. PF evaluates the perspectives of individual journals, instead of individual research articles, using keywords that are selected by PubMed independent of the authors of the papers. These keywords represent the concepts and topics of the individual articles published in the journal. Then, to quantify the degree of the perspective, it calculates the frequency of appearance of these concepts and topics before and after publication.

Thus, the frequency of appearance of key words before and after publication acts as a measure of degree of the perspecitive in terms of 'contributing to making given fields more popular'. If a given journal publishes several articles that contain many perspective key words, it is regarded as a high-perspective journal. Therefore, the PF value of a given journal, PFj, is defined as follows:

$$PF_j = \frac{A_j}{B_j}$$

where Bj is the number of articles published in the journal j, and Aj is the number of topics handled in the journal j which became more popular after the journal j was published. Thus, the PF value represents the average perspective of topics per article in journal j.

The MeSH (Medical Subject Headings) (Schulman, 2000; Stuart and Johnston) words are the most useful to represents the topics in each article, because (i) there is a vocabulary thesaurus for the life sciences organized by the NLM (National Library of Medicine), and (ii) PubMed (Schulman, 2000; Stuart and Johnston), which uses them, is one of the biggest databases of articles in the life sciences (see Methods). MeSH words are not written and attached by the author of each article, but by experts who are hired by NCBI. Therefore, PF is never affected by bias of the author, and is free from the problems associated with the traditional citation analyses.

An example is the life science journals published in 1997. Here, the Aj value can be obtained by counting the MeSH words filling the condition of $X/Y>0.5722$ in journal j on PubMed, where X is the total number of MeSH words appearing in the following two years (1998 and 1999), and Y is the total number of MeSH words appearing in the four consecutive years including the previous year (1996) and the following three years (1997, 1998 and 1999). '$X/Y>0.5722$' indicates the condition that the increment of a certain MeSH word appearance is included in the top 5 % of the total increment of all MeSH words appearing in 1997 (see Methods); i.e., if the frequency of a certain MeSH word appearance fills the X/Y>0.5722 condition, then the topic represented by this MeSH word becomes more popular after 1997.

One may think that the calculation of PF represents temporal trends in science. However, the span of X and Y in the equation of PF can be changed for evaluating long term perspectives such as Cumulative IF (Garfield, 1998) based on the numbers of citations counted over several years. For a comparison of journal quality, we calculated the PF values of 161 journals published in 1997 and examined the relationship between the IF and PF values (Table 1, Fig. 1 circle dots).

3. Perspective factor vs. impact factor

Although citing articles by authors and attaching MeSH words to articles by experts are completely independent of each other, there is a linear relationship between the IF and PF values with a positive Pearson's correlation coefficient, especially in the journals with IF<20(r=0.601, p<0.001). The linear correlation between the IF and PF values does not hold, however, in some cases. For instance, Cell, Nat Genet, Nat Med, New Engl J Med and Lancet, whose IF values are much larger than other journals, have PF values relatively smaller than the others. One should handle 'Nature' and 'Science' specifically because they are interdisciplinary scientific journals. Their IF and PF values are lower because of limited topics, mainly physics and chemistry, which appear in PubMed. Consequently, when handling 'Nature' and 'Science', we selected only articles related to life sciences (see Methods). With this restriction, the PF values of 'Nature' and 'Science' increased to 1.54 and 1.97 from 1.21 and 1.47, respectively (Table 1, Fig.1 astral dots). Similarly, with this restriction, the IF values of 'Nature' and 'Science' also became larger. Even under this consideration, the PF values of certain journals were relatively low when the corresponding IF values were very high, i.e., the journals with IF values over 20 did not have many topics that had become more popular than expected. One major reason for the non-linear relationship between the IF and PF values under the condition of IF>20 likely comes from the existence of 'hot papers' (Science Watch), 85 % of which are published in 'Nature', 'Cell' and 'Science'.

When the high-citation articles of 'Nature', 'Cell' and 'Science' were excluded from the calculation, the IF values decreased enormously, but the PF values were not affected much (Table 1, Fig.1 triangles). Articles dealing the fairness of the IF and citation analysis have argued against 'biased citation' (Adam, 2002; Bordons,Fernandez and Gomez, 2002; Kostoff, 1998; MacRoberts and MacRoberts, 1989; Massie, 2002; Seglen, 1997; Whitfield,Vale and Taylor, 2002), 'citation of secondary sources such as reviews' (Hecht,Hecht and Sandberg, 1998; Kostoff, 1998; MacRoberts and MacRoberts, 1989; Seglen, 1997), 'the size of audience in a specific field' (Kostoff, 1998; MacRoberts and MacRoberts, 1989; Seglen, 1997), and so on. Our analysis showed that the review journals had very low PF values compared with their very high IF values (Table 1, Fig.1 crosses). In addition, in spite our of expectations, there was no correlation between PF values and the size of the research field handled in the journals (r = -0.004)(Fig. 2). Finally, the PF value, but not the IF value, can exclude biased citation due to the nature of its definition.

It may be a worry that highly cited publications trigger the process in which professional indexers attach words or terms more favorably to them. If so, the definition of PF value itself should allow the high IF journals such as *Natur*e, *Cell*, *New Engl J Med* to gain high PF values. In reality, however, the PF values for *Nature* and *Cell* were not so high, and the PF value of *New Engl J Med* was much lower compared with other journals. Therefore the effect of highly cited publications to MeSH words attachment shouldbe negligible.

In conclusion, PF provides a new way of evaluating journal quality as 'perspective'. When comparing PF and IF values, one can see that the journals can be classified into three categories; high IF and low PF journals such as 'Nature', 'Science', 'Cell' and 'New Engl J Med', low IF and high PF journals such as 'J Comp Biol', 'Mol Phylogenet Evol' and 'Mol Biol Rep', and journals which have balanced IF and PF values such as 'FEBS Lett', 'J Biol Chem', 'EMBO J' and so on. The concept of evaluating perspective is now available for the assessment of research activities through journal assessment. Since PF calculation excludes the citation of articles, the resultant PF value is not affected by the various problems of citation analysis.

Materials and Methods

Article topics

PubMed (Schulman, 2000; Stuart and Johnston) has a vocabulary thesaurus, namely Medical Subject Headings (MeSH) (Schulman, 2000; Stuart and Johnston), for representing the content of each article. MeSH is composed three main classes, 'MeSH Heading' (Main headings), 'Subheading '(Qualifiers) and 'Name of Substance' (Supplemental Concepts) and MeSH Heading' and 'Name of Substance' are defined as the topics of articles, because 'Subheading' is used to qualify 'MeSH Heading' and indicates how the meaning of 'MeSH Heading' should be refined (i.e., how to deal with MeSH heading). There is repetition of MeSH words in a single article because of the modification of 'Subheading' and the duplication of 'MeSH Heading' and 'Name of Substance'. Therefore the repetitions were excluded, and one set of MeSH words without overlap per article was used to calculate the PF.

Topics becoming much more popular

To define topics that are increasingly studied, the increase rate of MeSH words attached to all articles published in 1997 was examined. There were 434478 articles published in 1997 and 5310920 MeSH words (46327 kinds) attached to them. For each

MeSH word, we calculated A/B where A is the number of articles published in 1998 and 1999 containing the MeSH, and B is the number of articles published in 1996, 1997, 1998 and 1999 containing the MeSH word. The mean value of A/B was 0.513 ± 0.049 (mean ± SD), but the distribution of A/B was not normal ($p<0.05$). From this result, the MeSH words included in the top 5% were defined as being increasingly studied ($A/B>0.5722$).

Life science articles on 'Nature' and 'Science' and their PF and IF

'Nature' and 'Science' contain topics other than life science. Life science articles were selected following the 'Subheading' attached to the articles; including *'Abnormalities'*, *'Adverse Effects'*, *'Agonists'*, *'Anatomy and Histology'*, *'Antagonists'*, *'Biosynthesis'*, *'Blood'*, *'Blood Supply'*, *'Cerebrospinal Fluid'*, *'Contraindications'*, *'Cytology'*, *'Deficiency'*, *'Diagnostic'*, *'Dosage'*, *'Embryology'*, *'Enzymology'*, *'Etiology'*, *'Genetics'*, *'Growth and Development'*, *'Immunology'*, *'Innervation'*, *'Metabolism'*, *'Microbiology'*, *'Parasitology'*, *'Pathology'*, *'Pharmacokinetics'*, *'Pharmacology'*, *'Physiology'*, *'Physiopathology'*, *'Poisoning'*, *'Secretion'*, *'Toxicity'*, *'Transmission'*, *'Ultrastructure'*, *'Urine'* and *'Virology'*. PF was then examined from only the life science articles, and the IF was estimated as follows; normal IF times {(sum of the citation number of life science article) by (sum of the total number of life science)} by {(sum of the citation number of all articles) by (sum of the total number of articles)}.

PF and IF after excluding high-citation articles of 'Nature', 'Science' and 'Cell'

Using Web of Science, the number of citations of articles of 'Nature' (only life science articles), 'Science' (only life science articles) and 'Cell' published in 1997 were counted for 2003/03/ ('Nature' and 'Science') and 2002/03/ ('Cell'). PF were then examined after excluding articles included in the top 5% of citations including Hot Papers. IF was estimated as follows; normal IF times {(sum of the citation number after excluding the top 5% high-citation life science article) by (sum of the total number articles after excluding the top 5% high-citation life science articles)} by {(sum of the citation number of all life science articles) by (sum of the total number of all life science articles)}.

Field size handled in the journals

The frequency of appearance of a given MeSH word in a certain year can be regarded as the size of a specific field that the MeSH word represents that year.

Therefore, the field size handled in a certain journal published in 1997, for example, can be defined as the average frequency of the MeSH words' appearance handled in the journal in 1997. Namely, the following equation can be used:

$$S = P/Q$$

where S is the field size handled in a journal, P is the sum of the frequency of individual MeSH words' appearance on PubMed in a given journal published in 1997, and Q is the total number of MeSH words handled in the journal.

Figure Caption

Fig.1

Correlation between IF and PF; the X axis is the Impact Factor in 1998 and the Y axis is the Perspective Factor in 1997. Circles indicate the scores which were calculated from all articles in each journal. Astral dots indicate the scores of 'Nature' and 'Science' which were calculated after articles were restricted to life science, Triangles indicate the scores of 'Nature', 'Science' and 'Cell' which were calculated after articles were restricted to life science and high-citation articles were excluded, and crosses indicate review journals.

Fig.2

Correlation between PF and the size of research fields; the X axis is the size of the research field handled in the journal and the Y axis is the Perspective Factor in 1997.

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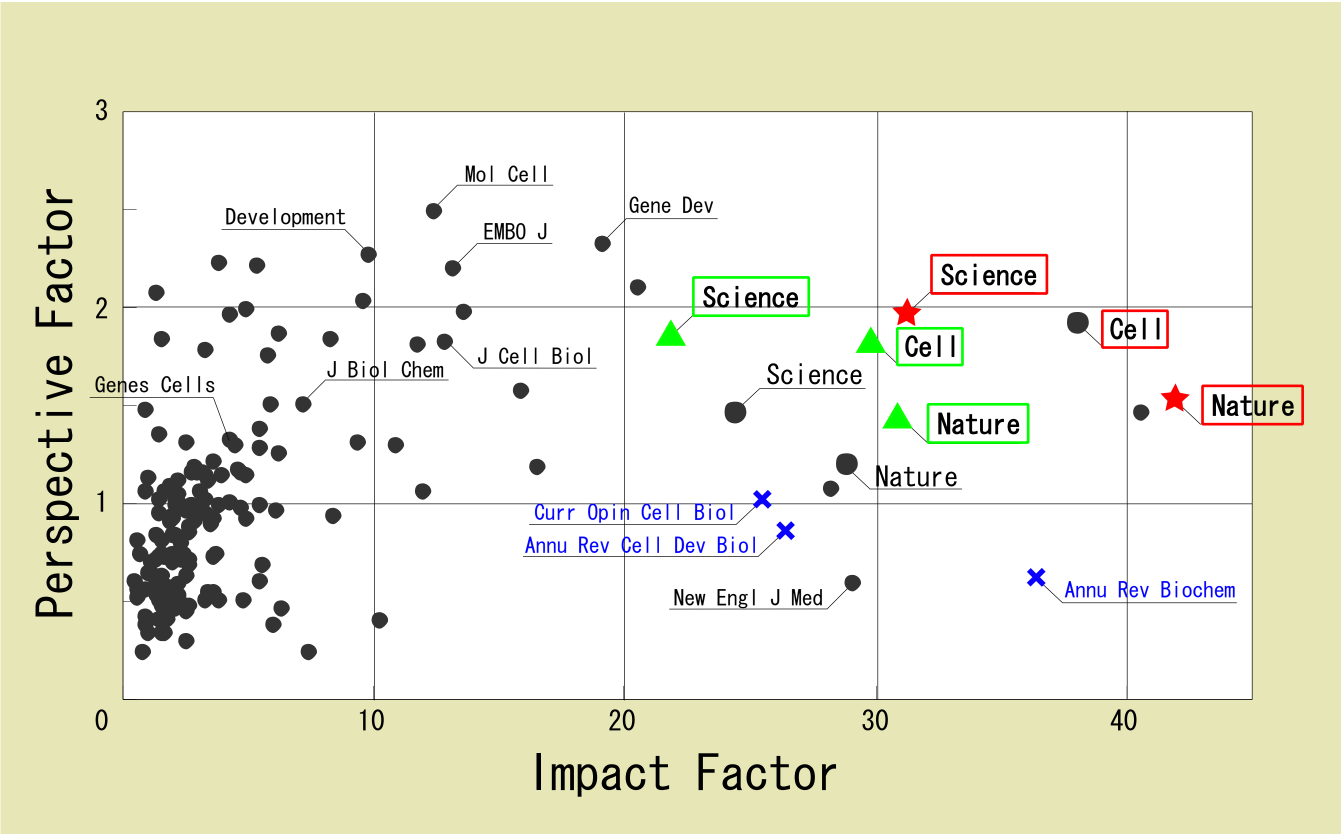
Table 1 **PF and IF of the journals in life science**

Journal Title[a]	IF[b]	PF[c]	Journal Title[a]	IF[b]	PF[c]	Journal Title[a]	IF[b]	PF[c]
Cell	38.1	1.93	Virology	3.6	0.93	Plant Cell Physiol	1.8	0.92
New Engl J Med	28.9	0.55	Genomics	3.5	0.90	Mol Immunol	1.8	1.10
Nature	28.8	1.21	J Neurophysiol	3.4	0.56	Genet Res	1.8	0.74
Science	24.4	1.47	Appl Environ Microbiol	3.4	1.12	J Neurovirol	1.7	0.48
Immunity	20.5	2.12	J Neuroimmunol	3.3	0.52	Histopathology	1.7	0.42
Genes Dev	19.1	2.34	J Mol Evol	3.3	1.79	Biotechniques	1.7	0.59
Neuron	16.5	1.19	Eur J Biochem	3.2	1.03	Histochem Cell Biol	1.7	0.55
J Exp Med	15.9	1.59	Dev Dyn	3.2	1.15	Neurochem Res	1.7	0.53
Nat Struct Biol	13.6	1.99	J Membr Biol	3.2	0.96	Dev Psychobiol	1.6	0.35
Embo J	13.2	2.21	Int Immunol	3.1	1.16	Int J Biochem Cell Biol	1.6	0.73
J Cell Biol	12.8	1.83	Mol Ecol	3.0	1.07	Virus Res	1.6	1.07
Mol Cell	12.4	2.50	Plant Mol Biol	3.0	1.16	Int J Dev Biol	1.6	0.75
Faseb J	11.9	1.07	Hum Genet	2.8	0.97	Biophys Chem	1.6	0.64
Plant Cell	11.8	1.82	Methods Enzymol	2.8	0.92	J Virol Methods	1.6	0.48
Am J Hum Genet	10.9	1.31	J Cell Biochem	2.8	1.20	Cell Mol Life Sci	1.5	0.82
Lancet	10.7	0.44	Mol Gen Genet	2.8	0.95	Med Microbiol Immunol	1.5	0.59
Development	9.7	2.27	J Struct Biol	2.8	1.17	Int J Dev Neurosci	1.5	0.35
Mol Cell Biol	9.6	2.04	Immunology	2.8	1.00	Mol Biol Rep	1.5	1.85
Hum Mol Genet	9.3	1.32	J Cell Physiol	2.7	1.01	Anat Embryol	1.5	0.52
J Neurosci	8.4	0.95	J Gen Virol	2.7	0.86	Cell Struct Funct	1.5	1.03
Mol Biol Cell	8.3	1.84	Chromosoma	2.7	0.89	J Biotechnol	1.5	0.74
Cereb Cortex	7.4	0.25	J Med Genet	2.6	0.70	Histol Histopathol	1.4	0.42
J Biol Chem	7.1	1.52	J Med Virol	2.6	0.72	Immunol Lett	1.4	0.96
J Gen Physiol	6.3	0.47	J Immunother	2.6	0.48	Histochem J	1.4	0.62
Oncogene	6.2	1.88	J Pineal Res	2.5	0.30	Immunobiology	1.4	1.37
Chem Biol	6.2	1.26	J Histochem Cytochem	2.5	0.64	J Comput Biol	1.3	2.08
Mol Microbiol	6.1	0.97	Dev Genet	2.5	1.32	Clin Biochem	1.3	0.54
Brain Res Dev Brain Res	6.0	0.38	Eur J Cell Biol	2.5	0.98	J Protein Chem	1.3	0.72
J Mol Biol	5.8	1.51	Placenta	2.5	0.46	Mol Cell Biochem	1.3	0.62
Plant J	5.8	1.77	Mol Reprod Dev	2.4	0.75	Res Microbiol	1.3	0.85
Hum Gene Ther	5.6	0.69	Immunogenetics	2.3	0.80	Immunopharmacology	1.2	0.63
J Cell Sci	5.5	1.30	J Autoimmun	2.3	0.72	Biol Cell	1.1	0.71
Eur J Immunol	5.4	1.39	Chromosome Res	2.3	0.75	J Appl Microbiol	1.1	0.65
Mol Pharmacol	5.4	1.00	Yeast	2.2	0.84	Rissue Cell	1.0	0.66
Gene Ther	5.4	0.61	J Biochem	2.2	1.00	Mol Biotechnol	1.0	0.34
Mol Biol Evol	5.3	2.23	Hum Immunol	2.2	0.54	Somat Cell Mol Genet	0.9	1.14
Nucleic Acid Res	4.9	0.94	Dna Cell Biol	2.2	1.02	J Mol Recognit	0.9	1.48
Mol Med	4.9	1.15	J Neurocytol	2.2	0.60	Cell Biol Int	0.9	0.56
Mech Dev	4.9	2.01	Brain	2.2	0.53	Biochem Genet	0.9	0.44
J Physiol	4.7	0.52	Eur J Hum Genet	2.2	1.12	Pathobiology	0.8	1.08
J Neurochem	4.7	0.99	Cell Immunol	2.1	1.06	J Biochem Biophys Methods	0.8	0.40
Biochemistry	4.6	1.16	Differentiation	2.1	0.85	Gen Physiol Biophys	0.7	0.25
Plant Physiol	4.5	1.19	Cell Tissue Res	2.1	0.54	Appl Biochem Biotechnol	0.7	0.75
Genetics	4.5	1.31	Ultramicroscopy	2.0	1.00	Res Commun Mol Pathol Pharmaco	0.6	0.56
Genes Cells	4.3	1.33	Am J Med Genet	2.0	0.47	Cell Biochem Funct	0.5	0.53
Cell Growth Differ	4.3	1.97	Gene	2.0	1.03	J Immunoassay	0.5	0.57
J Leukoc Biol	4.3	1.01	Anal Biochem	2.0	0.71	Cell Biol Toxicol	0.5	0.82
Biochem J	3.9	1.15	Biosci Rep	2.0	0.84	Eur J Histochem	0.5	0.61
Eur J Neurosci	3.8	0.52	Methods Cell Biol	2.0	0.57	Nature(only life science issues)	42.0	1.54
J Bacteriol	3.8	1.00	J Med Microbiol	2.0	0.52	Science(only life science issues)	31.2	1.97
Mol Phylogenet Evol	3.8	2.24	Cell Mol Neurobiol	2.0	0.74	Cell(excluding high citation issues)	29.9	1.84
Br J Pharmacol	3.7	0.74	J Mol Neurosci	1.9	0.73	Nature(excluding high citation issues	31.2	1.45
Neuroscience	3.6	0.74	J Clin Immunol	1.9	0.93	Science(excluding high citation issue	21.8	1.85
Febs Lett	3.6	1.22	Immunol Cell Biol	1.9	0.94			
J Clin Microbiol	3.6	0.55	Cytogenet Cell Genet	1.9	0.57			

[a]The notation system of journals follows to PubMed.
[b]Impact Factor in 1998
[c]Perspective Factor in 1997



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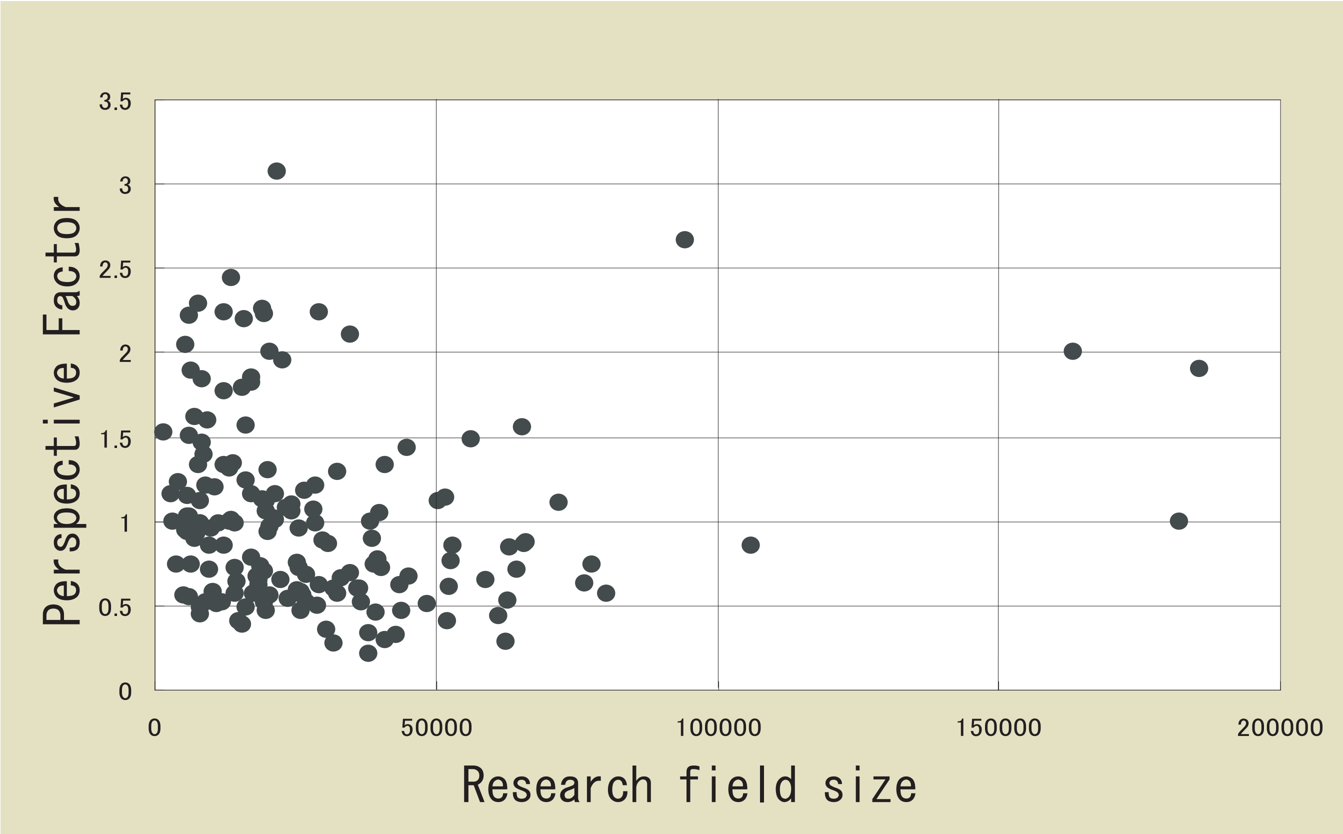

Figure 2 R.L.Ohniwa et al.