BRIEF COMMUNICATION

Does International Collaboration Yield a Higher Citation Potential for US Scientists Publishing in Highly Visible Interdisciplinary Journals?

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Generally, multicountry papers receive more citations than single-country ones. In this contribution, we examine if this rule also applies to American scientists publishing in highly visible interdisciplinary journals. Concretely, we compare the citations received by American scientists in Nature, Science, and the Proceedings of the National Academy of Sciences of the United States of America (PNAS). It is shown that, statistically, American scientists publishing in Nature and Science do not benefit from international collaboration. This statement also holds for communicated submissions, but not for direct and for contributed submissions, to PNAS.

Introduction

In the early 1990s, Narin and his collaborators (Narin & Whitlow, 1990; Narin, Stevens, & Whitlow, 1991) observed that the number of received citations for multicountry papers are considerably higher than for single-country ones, and even twice as high as for single-country single-institution papers. In a recent paper, Smith, Weinberger, Bruna, and Allesina (2014) even take the number of collaborating countries into account. They find that as the number of countries in the byline increases, articles are more likely to be published in journals with higher impact and accrue more citations than peer publications originating from fewer countries. Concrete citation results, however, differ by field and by country pairs. Between the publication dates of these two papers, van Raan (1998) also published data on Dutch astronomers showing that, although internationally collaborated articles have a higher percentage of self-citations than nationally collaborated or articles with one institutional address, the number of received citations, excluding self-citations, is still considerably higher than for the two other categories.

The intellectual requirements for acceptance of submissions in Nature, Science, or the Proceedings of the National Academy of Sciences of the United States of America (PNAS) can hardly be compared with those of an average journal included in Thomson Reuters’ Web of Science. These three multidisciplinary journals are the ones we will focus on. They will be referred to as top journals (just as a shorthand, no absolute ranking of all journals is implied). Moreover, we posit that, although the United States is the leading scientific country of the world, this does not preclude that US scientists, too, may benefit from collaborating with colleagues from other countries. This is particularly true as smaller countries such as Switzerland, Iceland, Denmark, and the Netherlands often perform better than the United States in relative terms. Indeed, these countries are all ranked before the United States in the SCImago-ranking according to citations per publication over the period 1996–2013.
These observations lead to the following hypothesis:

**Hypothesis:** American-only publications in *Nature*, *Science*, and *PNAS* receive on average a significantly lower number of citations than American internationally collaborated publications.

Concretely, we wonder if the combination of American scientists with publications in top journals follows the general rule that the number of received citations for multicity country papers is higher than for single-country papers. From the point of view of the sociology of science such exceptions to the rule are, in our opinion, of special interest, as they point to possible modeling limits. Moreover, the idea that international collaboration always and for everyone leads to more citations could be added to the seven myths described by Glänzel (2008).

**Data Collection**

Publication and citation data were retrieved from Thomson Reuters’ Web of Science (WoS) on November 4, 2014. We only included the three multidisciplinary journals mentioned above and restricted publications to those “of article type.” Citations, including author self-citations, received by articles published in the years 2004 to 2008 were collected year by year. As citation data were collected on November 4, 2014 articles have a different citation window. As comparisons are made year by year (see further) this has no influence on our results. By way of interest, we also collected information for articles with at least one American address. Table 1 shows the total number of articles published in each of the three journals: maybe surprisingly, given the popularity of these journals, *Nature* and *Science* have a slightly decreasing trend in number of articles over the period 2004–2008, whereas *PNAS* has a slightly increasing trend in absolute as well as relative numbers of publications.

Table 2 shows the yearly numbers of articles with at least one American address and their subdivision into only American contributions and international collaborations (all three journals together). The percentage of articles in the three journals with at least one American address stays more or less stable at about 72%, whereas the percentage of articles with only American addresses decreases somewhat, namely from 49% to 45%.

**Methods**

We used the Mann–Whitney test to explore the statistical validity of the null-hypothesis:

**H₀:** American-only and American internationally collaborated publications in *Nature*, *Science*, and *PNAS* are of equal citation potential as shown by received citations in the long run: concretely from 6 to 10 years.

In view of the reflections above, we expect to reject this hypothesis.

We recall that it has been stated by Huber and Wagner-Döbler (2003) that the Mann–Whitney test can be used on informetric data, regardless of the fact that such data often have many ties. These ties reduce the discriminatory power of the test but do not preclude its use. In case of ties, median ranks are used. To include only full years we took citation windows ending in the year 2013.

For each publication year, we performed separate Mann–Whitney tests. Actual calculations were performed using SPSS 16.0 (Chicago, IL), which includes a correction for ties.

We performed the investigation in three steps. First we performed the test for all articles published in any of the three top journals. Second we considered each journal separately and in a third step we made a distinction between the three tracks of *PNAS*. Indeed, *PNAS* had three ways, referred to as tracks, of submitting a paper: the contributed track, the communicated track, and the direct submissions (Aldhous, 2014). Direct submissions are handled as submissions to any other journal, contributed submissions are submissions by members of the academy who may

| TABLE 1. Number of publications (only article type) in the three top journals. | 2004 | %   | 2005 | %   | 2006 | %   | 2007 | %   | 2008 | %   |
|-------------------------------|------|-----|------|-----|------|-----|------|-----|------|-----|
| Nature                        | 916  | 18.8| 986  | 19.5| 906  | 18.0| 786  | 15.5| 868  | 16.8|
| Science                       | 873  | 17.9| 881  | 17.4| 830  | 16.5| 818  | 16.1| 809  | 15.6|
| PNAS                          | 3077 | 63.2| 3196 | 63.1| 3290 | 65.5| 3481 | 68.5| 3501 | 67.6|
| Total (100%)                  | 4866 | 5063| 5026 | 5085| 5178 | 5178|

| TABLE 2. American articles.   | 2004 | %   | 2005 | %   | 2006 | %   | 2007 | %   | 2008 | %   |
|-------------------------------|------|-----|------|-----|------|-----|------|-----|------|-----|
| USA (at least one American)   | 3535 | 100 | 3692 | 100 | 3665 | 100 | 3641 | 100 | 3754 | 100 |
| USA (only American)           | 2394 | 67.7| 2387 | 64.7| 2332 | 63.6| 2256 | 62.0| 2350 | 62.6|
| USA (international collaboration) | 1,141| 32.3| 1,305| 35.3| 1,333| 36.4| 1,385| 38.0| 1,404| 37.4|
choose who will review their paper. Finally, the communicated track consists of manuscripts sent by nonmembers to colleagues in the academy, who would guide these submissions through review. The communicated track was abolished in 2010. Aldhous found that the difference between citation rates for directly submitted and contributed papers was about 4.5% fewer citations for contributed papers, and that this difference was statistically significant.

We used Aldhous’ (2014) data that made a distinction between these three tracks (see Table 7). It turned out that 214 articles were missing in these data. These were checked manually. Among these, 136 papers were added to the track to which they belonged, and it turned out that colloquium papers, published in supplements of *PNAS*, and some perspectives and commentaries, although classified as articles in the WoS, did not have a track assigned. These are not used in our analysis.

### Results

#### Considering These Three Journals Together

In a first step, we consider the three top journals together. A summarizing table is shown as Table 3. For each publication year we show the number of articles with at least one American author and at least one author working at a non-American institute, and the number of articles with only American authors, in the sense that all affiliations are American. The last row shows *p*-values for a two-sided test. We obtained the expected results, see Table 3 that the null-hypothesis is rejected, and hence American scientists benefit from collaborating with foreign colleagues.

#### Considering Each Journal Separately

One may rightly observe that bringing these three journals together is an artificial procedure. One should better study each journal separately. This is what is done in the second step. The results are shown in Tables 4–6. These results hold a surprise in the sense that the expected result of the first step is completely due to *PNAS*. For *Nature* and *Science*, there is no reason to conclude that Americans benefit from international collaboration.

Figures 1–4 show the average number of citations per publication for articles in *Nature*, *Science*, and *PNAS* (two types, discussed later). All citation windows end in 2013. In some years, this average is for *Nature* higher for collaborated articles than for Americans only, whereas in other years the opposite is true. For *Science*, the average number of citations per publication is for most years higher for collaborated articles, but the publication year 2005 is an exception. Anyway, the Mann–Whitney test suggests that this difference is not significant. For the two types of articles in *PNAS*, collaborated articles have always a higher average number of citations per publication than American-only ones.

### TABLE 3. Results of Mann–Whitney test for the three top journals together.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated  | 1141 | 1305 | 1333 | 1385 | 1404 |
| USA only         | 2394 | 2387 | 2332 | 2256 | 2350 |
| *p*-value (2-sided) | .000 | .000 | .000 | .000 | .000 |

### TABLE 4. Results of Mann–Whitney test for *Nature*.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated  | 239  | 294  | 253  | 247  | 270  |
| USA only         | 354  | 340  | 338  | 292  | 343  |
| *p*-value (2-sided) | .587 | .422 | .476 | .097 | .252 |

### TABLE 5. Results of Mann–Whitney test for *Science*.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated  | 239  | 281  | 275  | 262  | 240  |
| USA only         | 391  | 352  | 341  | 316  | 339  |
| *p*-value (2-sided) | .401 | .770 | .985 | .736 | .173 |

### TABLE 6. Results of Mann–Whitney test for *PNAS*.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated  | 663  | 730  | 805  | 876  | 894  |
| USA only         | 1649 | 1695 | 1653 | 1648 | 1668 |
| *p*-value (2-sided) | .000 | .000 | .000 | .005 | .007 |

![FIG. 1. Average number of citations per paper in *Nature*.](image-url)
Focusing on PNAS

The surprising results of the previous section lead us to take a closer look at PNAS. Bearing in mind that there are three submission tracks for this journal, we considered each track separately. Summary data are shown in Table 7, while outcomes, in terms of p-values, of the Mann–Whitney test, are shown in Tables 8–10.

Clearly, for the direct submissions the hypothesis that Americans do not benefit from international collaboration should be rejected. For contributed submissions a somewhat similar result can be seen, be it that there is one exceptional year (2007) and p-values are usually larger than for the direct submissions. Finally, communicated contributions show mixed results, but generally point to less or considerably less difference between US-only and US collaborated papers: p-values for each year are larger than for the other two tracks.

Conclusion

It is clear that, statistically, American authors, in the sense of authors with an American address, directly
submitting articles for publication in PNAS (and accepted, which in 2013 happened only for 18% of the published articles [Aldhous, 2014]) benefit in terms of received citations from international collaboration. However, this is less or not the case for contributed or communicated articles and not at all for American authors publishing in Nature and Science.

Of course, this does not exclude the possibility that also in these journals there may be differences between American-only and internationally collaborated articles. For instance, the percentage of articles in the top 1% of received citations in these journals or in the WoS as a whole may differ (Leydesdorff, Wagner, & Bornmann, 2014). Moreover, a reviewer correctly pointed out that excluding author self-citations would lead to a clearer picture.

These results indicate that when it comes to international collaborations and its possible benefits, a one-size-fits-all approach is certainly not advised. This exploratory investigation opens the door for a closer scrutiny to find out if Nature and Science are really exceptions to the general rule, or if the United States is an exceptional country, or is it the combination of these two factors that led to the observed results.

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TABLE 8. Results of Mann–Whitney test for communicated papers in PNAS.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated | 193  | 174  | 182  | 197  | 140  |
| USA only         | 406  | 420  | 419  | 342  | 286  |
| p-value (2-sided)| .062 | .245 | .020 | .443 | .809 |

TABLE 9. Results of Mann–Whitney test for contributed papers in PNAS.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated | 204  | 228  | 254  | 234  | 260  |
| USA only         | 571  | 585  | 496  | 462  | 454  |
| p-value (2-sided)| .007 | .012 | .007 | .112 | .016 |

TABLE 10. Results of Mann–Whitney test for direct submission papers in PNAS.

| Publication year | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------|------|------|------|------|------|
| USA collaborated | 265  | 322  | 369  | 444  | 493  |
| USA only         | 646  | 677  | 737  | 829  | 914  |
| p-value (2-sided)| .000 | .003 | .001 | .030 | .025 |