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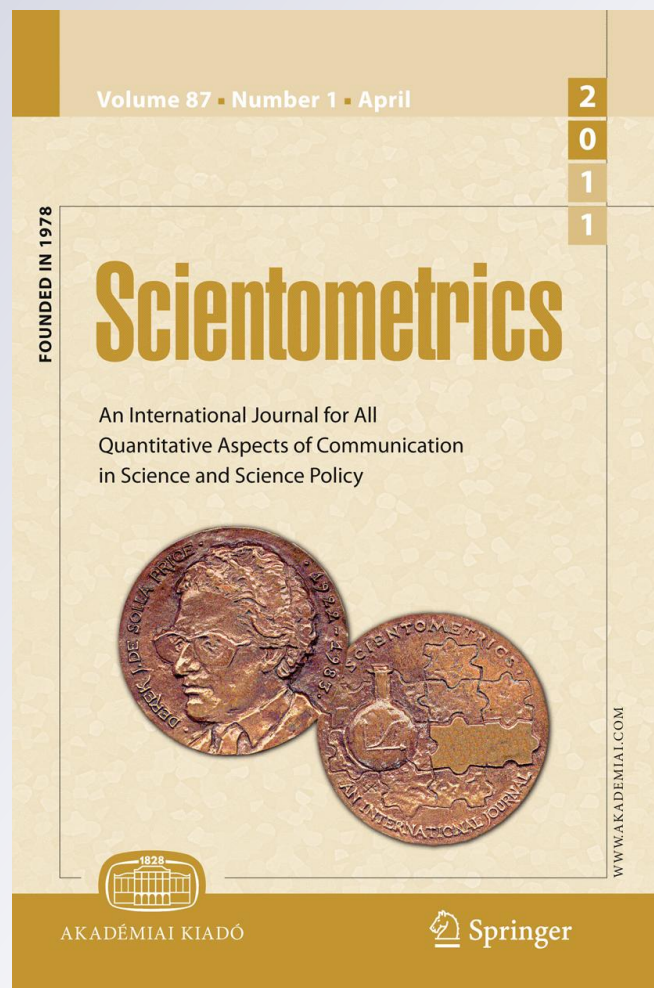
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International collaboration in psychology is on the rise

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Abstract There has been a substantial increase in the percentage for publications with co-authors located in departments from different countries in 12 major journals of psychology. The results are evidence for a remarkable internationalization of psychological research, starting in the mid 1970s and increasing in rate at the beginning of the 1990s. This growth occurs against a constant number of articles with authors from the same country; it is not due to a concomitant increase in the number of co-authors per article. Thus, international collaboration in psychology is obviously on the rise.

Keywords International collaboration · Psychological publications · Linear mixed model · Historical trend

The world is growing together and scientific collaboration is one very encouraging piece of evidence for it. How is this trend reflected in scientific publications? Comprehensive analyses of bibliometric ISI records, distinguishing between international and national articles, have been available at least since the year 2000 (National Science Board 2000, chapter 6; 2008, chapter 5, table 5-37). In 2005, 27% of journal articles with a US author involved at least one co-author from a different country, up from 17% in 1995; the highest rate of international articles (58%) was determined for astronomy (1995: 42%); psychology is listed with 7.7% in 1995 and 13.6% in 2005. In a study recently commissioned for the UK Office of Science and Innovation, Adam et al. (2007) determined the number of collaborative articles between nine countries (UK, USA, Canada, France, Germany, India, Japan, Australia, China) for seven fields of research (clinical, health, biological sciences, environment, mathematics, physical sciences, and engineering). Growth ratios for the two periods 1996–2000 and 2001–2005 ranged between 1.16 and 2.15.

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A remarkable linear increase from 3% in 1990 (when this journal was founded) to 31% in 2008 was reported for *Psychological Science* (Kliegl 2008, Fig. 2). There are three questions to be followed up here: First, how does this trend look for journals with a longer history than *Psychological Science*? Second, how representative is this trend across journals devoted to basic research in psychology? And, third, does the increase in percentage of internationally co-authored articles occur against growth or decline in the absolute number of “national” articles (i.e., articles with all authors from the same country)? In addition, we show that the results are not simply due to a concomitant increase in the number of authors per article or due to differences in developmental trends between journals.

Method

Analyses are based on 26,722 articles and reviews published from 1975 to 2007 in 12 psychology journals. Our selection represents basic experimental psychological research with journals that have enjoyed a very high reputation in the various subfields of this discipline. Most of them are published by the American Psychological Association (APA), but we also included the major journals from the Association for Psychological Science (APS), the Psychonomic Society (PS), the Society for Psychophysiological Research (SPR); one of them belongs to a commercial publishing house. Specifically, the journals are *Biological Psychology* [Elsevier], *Developmental Psychology*, *Journal of Experimental Psychology: General*, *Journal of Experimental Psychology: Human Perception and Performance*, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *Journal of Personality and Social Psychology*, *Psychology and Aging*, *Psychological Bulletin*, *Psychological Review* [all APA], *Psychological Science* [APS], *Psychonomic Bulletin & Review* [PS], and *Psychophysiology* [SPR]. With the exception of the somewhat more recently started premier APS and PS journals, the other journals have held a high reputation for at least 20 years. Information was retrieved from the *ISI Web of Science* (Thomson Scientific) during the second quarter of 2008.

We categorized records by journal name, year of publication, and whether the article was by institutional authors from at least two countries (international) or by an institutional author or several authors from the same country (national). Authors may, of course, be of different nationalities than the institutes they list as their affiliations. A few single-author articles (85) listed affiliations with institutions in different countries; they were classified as national articles. Graphics were produced with the *lattice* package (Sarkar 2008) and inferential statistics were based on linear mixed models (LMMs) using the *lmer* program (*lme4* package; Bates and Maechler 2010). Both packages are part of the R environment for statistical computing and graphics (R Development Core Team 2010).

Results

The answers to the first two questions about the long-term historical trend for percentages of international articles and its consistency across different journals are displayed in Figs. 1 and 2. The percentage of international articles grows at constant rate of 7.4% as estimated from a regression of log percentage on year with year centered at 1990. This amounts to a linear increase of about 1/3% per year from 1975 to 1990 and 1% per year since then. The panels of Fig. 2 display this trend separately for the 12 journals, including also a

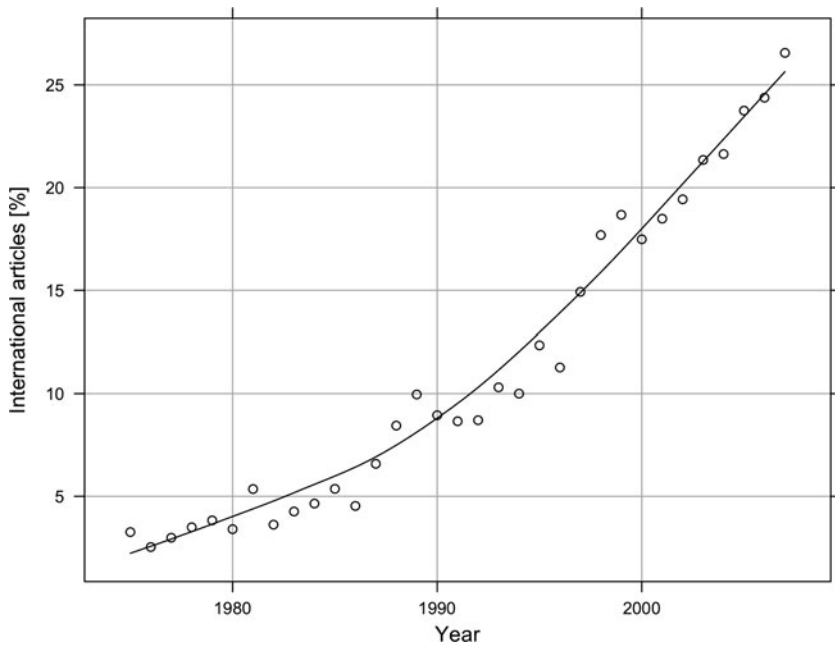


Fig. 1 Percentage of articles per year (1975–2007) with authors from different countries (international articles), pooling articles from 12 psychology journals (see Fig. 2). Percentage of international articles grows at a constant rate of 7%

loess-based smooth within each panel. Journals published since at least 1975 tend to show the curvilinear or bilinear trend of Fig. 1. Descriptive statistics about the database (i.e., total number of articles/reviews, overall percentage and percentage of international articles in last three years) is provided in the left part of Table 1.

The right part of Table 1 displays “estimates” of the percentage of international articles in the year 1990 as well as “estimates” of the linear slopes from 1975 to 1990 and from 1990 to 2007 for each journal. Strictly speaking these are the conditional modes evaluated at the estimated random effects of a linear-mixed effect model specifying the 12 journals as a random factor (yielding an estimate of the variance of the percentage of international journals in 1990) and estimating the variances of journal slopes prior to and after 1990. Note that for journals starting after 1990, the fixed effect slope for the pre-1990 period is returned as the best estimate. The increase in international articles is very pervasive.

Primarily for ease of interpretation, we fitted two linear slopes to percentages of international articles to document the accelerated growth of articles of this type. Is this growth due to an increase in the total number of publications or due to a decrease in the number of national articles (or both)? Figure 3 displays the log number of publications for national and international articles for the years 1975–2007, with articles pooled across journals. Growth has been much stronger for international than for national articles. Thus, the historical increase in international articles did not occur at the “cost” of a reduction of national ones.

As shown in Fig. 4, the lines in Fig. 3 smooth across substantial differences in developmental trends between the 12 journals. For most journals, the number of national articles (the top line in each panel) has not changed much across the last 33 years, but there are

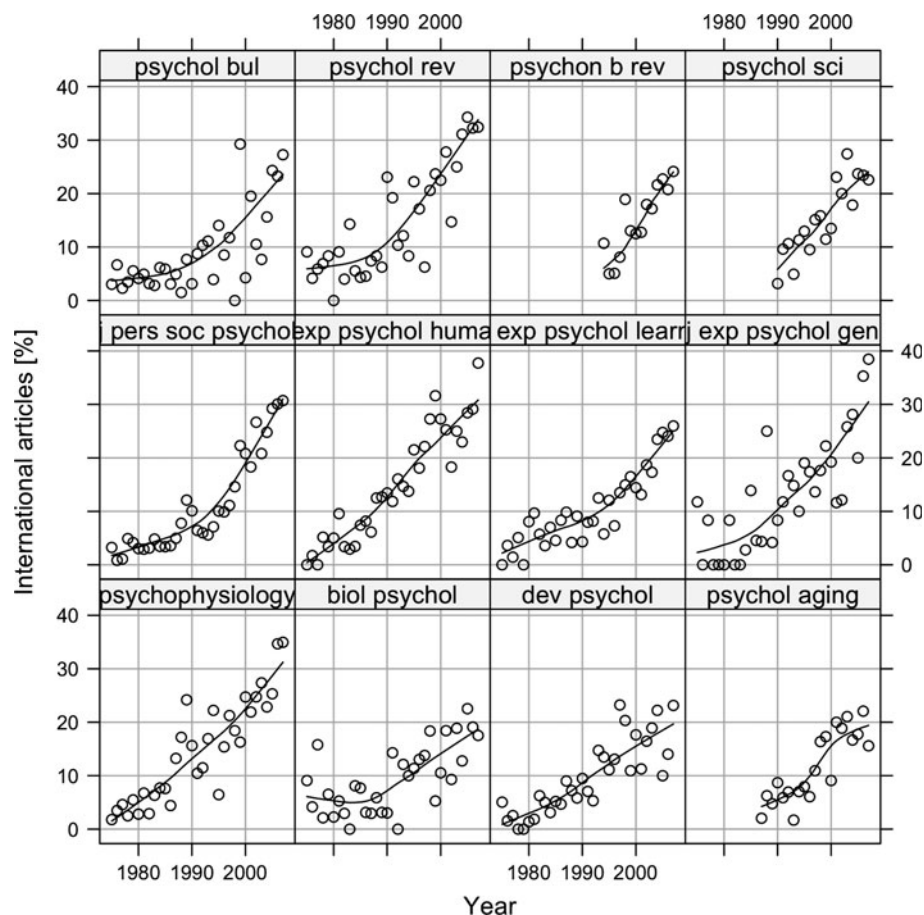


Fig. 2 Percentage of international articles per year (1975–2007), separately for 12 psychology journals

exceptions: Journals that started in the last 20 years such as *Psychological Science* or *Psychonomic Bulletin and Review* show growth; some of the others, such as the *Journal of Personality and Social Psychology* and *Psychological Bulletin*, evince a decrease in number of national articles.

For statistical inference, we regressed the log numbers of articles on type of article (national, coded as 0, and international, coded as 1), linear and quadratic trends of time (centered at 1990), and the interactions between these trends and type of journal. Journal was specified as a random factor. We also estimated the variability between journals for all fixed effects as well as the correlations between them. Estimates are reported in Table 2. The first three columns describe the regression line for the national articles; the coefficients for international articles reflect the difference to the corresponding coefficients for national articles, that is the coefficients for international articles can be computed by adding the corresponding coefficients. The results are straightforward. Overall (after statistically controlling for between journal differences), there is no significant change in log number of national articles across the 33 years—neither in the linear nor in the quadratic component

Table 1 Descriptive statistics and best linear unbiased estimates (BLUPs) for percentages of international articles for 11 psychology journals (see Fig. 2)

Journal	First year	N articles	International articles (%)		LMM estimates (%) (conditional modes)		
			Overall	2005–2007	Mean 1990	Slope 1975–1990	Slope 1990–2007
Psychophysiology	1975	2,596	15	32	10.91	0.52	1.13
Biol Psychol	1975	1,347	11	19	6.02	0.10	0.83
Dev Psychol	1975	3,177	10	17	7.36	0.40	0.83
Psychol Aging	1987	1,306	12	19	5.13	0.36	0.95
J Pers Soc Psychol	1975	6,279	10	30	6.61	0.33	1.26
J Exp Psychol Human	1975	2,592	17	32	10.73	0.58	1.25
J Exp Psychol Learn	1975	2,706	11	25	6.87	0.28	1.00
J Exp Psychol Gen	1975	883	14	32	8.84	0.41	1.16
Psychol Bull	1975	1,964	8	25	5.67	0.20	0.92
Psychol Rev	1975	946	16	33	9.85	0.33	1.23
Psychon B Rev	1994	1,269	18	23	4.87	0.35 ^a	1.02
Psychol Sci	1990	1,707	18	23	6.44	0.35 ^a	1.07

Note: N of percentages for linear mixed-effects model: 350; $\log\text{Lik} = -1032$; $\text{deviance} = 2058$, $\text{REML deviance} = 2064$. Fixed effects: mean for 1990 = 7.4% ($SE = 0.8$, $t = 8.9$); slope for 1975–1990 = 0.35 ($SE = 0.09$, $t = 3.9$); slope for 1990–2007 = 1.06 ($SE = 0.07$, $t = 14.1$). Random effects: sd (1990) = 2.40; sd (slope 1975–1990) = 0.19; sd (slope 1990–2007) = 0.19; sd (resid) = 4.29

^a Pre-1990 slope estimates based on fixed effects

(t -values < 1.0), but there is a highly significant difference between the linear trends for national and international articles ($t = 12.98$).

The overall pattern is accompanied by reliable variance between journals for all estimated coefficients (see *Random Effects* in Table 2). From these estimates, we can compute the conditional modes of the random effects, Pinheiro and Bates (2000) for each of the 12 journals. These coefficients are also listed in Table 2; they basically mirror the differences between the journal curves shown in Fig. 4.

There has been an increase in the total number of articles in basic psychological research. International articles have profited from this development. There is, however, one potential confound: Historically, there has also been a change in the mean number of authors. Already Smith (1958) reported an increasing trend in the percentage of papers by two and three authors, a decreasing trend in the percentage of papers by one author, and a trend toward an increasing mean number of authors for articles published in the *American Psychologist* in the years 1946–1958. Single-author papers are national articles, but the increase in number of international articles could be due to a correlated increase in the number of authors per article. Possibly, the increase in international articles rides on an over-proportional increase in the number of collaborating authors—even if there was only a remote chance that this should be the case. Indeed, the data clearly refuted this hypothesis. As shown in Fig. 5, larger growth rates were observed for international than national articles, irrespective of whether they were written by 2, 3, or 4 or more authors.

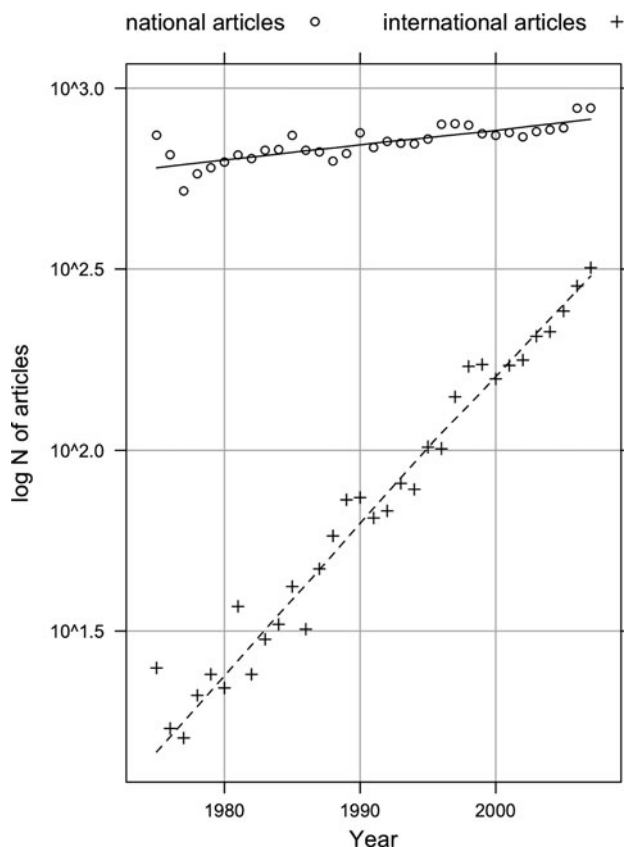


Fig. 3 Log number of international articles (*bottom line*) in comparison to the log number of national articles (*top line*) from 1975 to 2007, pooling articles from 12 psychology journals (see Fig. 4)

Thus, the increase in international collaboration remains even after stratification by the number of authors. Interestingly, the log number of single-author papers exhibits accelerated decline over the years.

Discussion

The number of articles co-authored by psychological scientists from different countries is increasing. This increase of international publications is absorbed by new journals and expansions of old journals rather than by reduction of the number of national publications. Overall the development of the percentage of international articles appears to be well characterized by exponential growth with a constant rate of about 7% per year; linear increments were around 1/3% before 1990 and have been above 1% during the last 17 years.

The smooth overall growth is complemented by varied growth and decline curves seen for the national-article lines at the level of journals (i.e., Fig. 4). Thus, in which journals the growing number of articles will be published depends on poorly understood

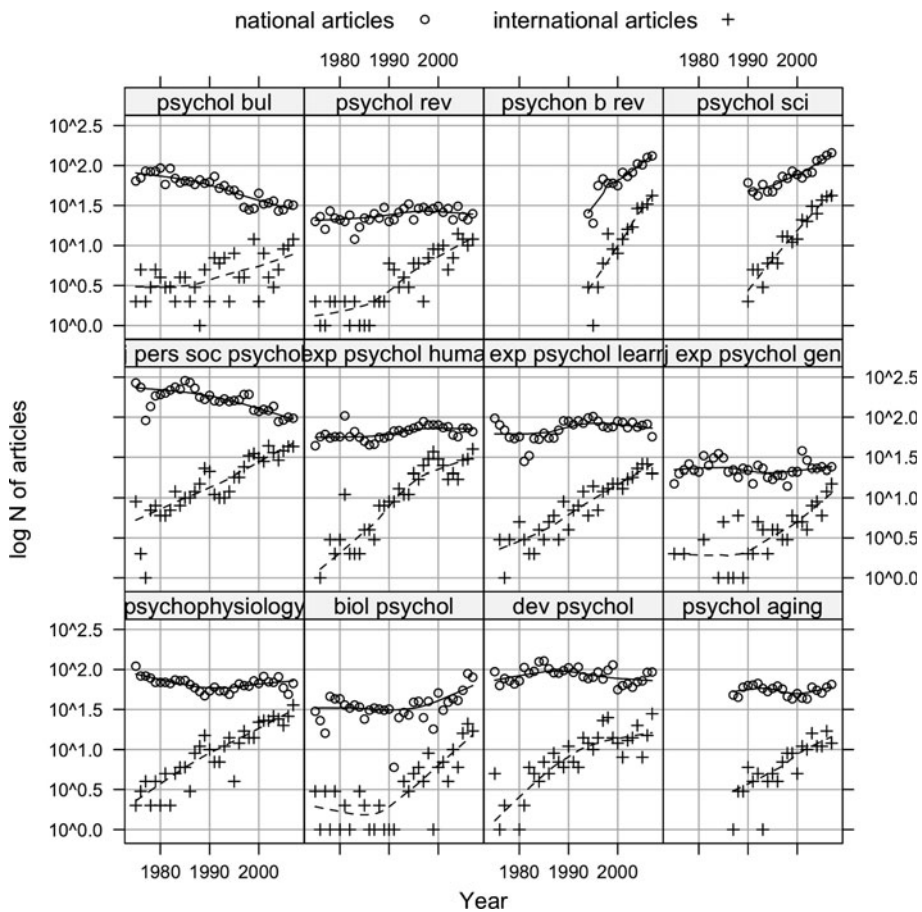


Fig. 4 Log number of international articles (*bottom lines*) in comparison to the log number of national articles (*top lines*) from 1975 to 2007, separately for 12 psychology journals

sub-disciplinary (perhaps also interdisciplinary) dynamics. For example, on the one hand, the decrease in number of articles appearing in the APA's *Psychological Bulletin* is largely due to moving methodological contributions from this journal to APA's *Psychological Methods*, newly founded in 1996. Of course, reputation and fashion will also exert their force at this levels and there may also be some, we suspect a very small, contribution from increasing demand for journal space from international submissions. On the other hand, the increases for *Psychological Science* and *Psychonomic Bulletin and Review* are what one would expect from startup journals. These kinds of wheeling and dealing reshuffle publications between journals but apparently they do not much affect the smooth general growth.

Interestingly, as far as international articles are concerned, all journals show growth, but growth rates differ significantly. In general, the growth for international articles appears to be somewhat decoupled from the dynamics visible for national articles, presumably because linear growth was quite subtle for a long time (i.e., below 0.3% per year) and did not represent a strong competition for journal space nor was it a political issue.

Table 2 Fixed and random effects and conditional modes for log counts of international and national articles for 12 psychology journals

	Linear mixed-effects model estimates					
	National articles			Diff for international articles		
	Interc. (1990)	Linear 1975–2007	Quad 1975–2007	Intern.	Linear 1975–2007	Quad 1975–2007
Fixed effects						
Estimate	1.73	0.60	0.37	−0.90	7.14	0.66
SE of estimate	0.07	0.77	0.41	0.03	0.55	0.43
<i>t</i> -value (i.e. Est/SE)	25.78	0.78	0.92	−31.04	12.98	1.53
Random effects (SD)	0.23	2.54	1.22	0.09	1.62	1.11
Journal conditional modes						
Psychophysiology	1.83	−0.50	0.24	−0.82	8.37	0.11
Biol Psychol	1.54	1.77	1.73	−0.92	4.84	2.29
Dev Psychol	1.92	−0.80	−1.11	−0.97	8.64	−0.35
Psychol Aging	1.74	−0.12	0.28	−0.98	6.41	1.39
J Pers Soc Psychol	2.20	−2.30	−0.77	−0.99	9.69	−0.16
J Exp Psychol Human	1.82	1.19	−0.37	−0.80	9.18	−1.20
J Exp Psychol Learn	1.85	1.02	−0.12	−0.93	8.02	−0.10
J Exp Psychol Gen	1.38	0.57	0.16	−0.79	6.09	0.77
Psychol Bull	1.70	−3.66	−0.61	−0.99	6.31	1.99
Psychol Rev	1.41	0.72	0.44	−0.74	6.49	0.58
Psychon B Rev	1.62	5.47	2.80	−0.91	5.06	1.69
Psychol Sci	1.78	3.86	1.83	−0.91	6.54	0.89

Note. *N* of cells: 700, *logLik* = 309, *deviance* = −627; *REML deviance* = −618; resid SD = 0.14

For example, there never was an official APA policy to increase or restrict the number of international articles (Rayner, personal communication, June 18, 2008).

International collaboration is definitely on the rise across all of science. The growth is likely to be linked to cultural innovations such as the introduction of web and email correspondence in the 1980 s. It is the result of a not so frequent convergence of interest of national policies and individual scientists. Government policies and individual competition for funds are both driven in part by the need for increasing specialization in various subfields of research. As a result, student and scientist exchange programs are actively advertised and implemented. Review panels of Deutsche Forschungsgemeinschaft, for example, often use evidence of international collaboration as one positive indicator in grant evaluations. As a consequence, there has been an increase in the availability of international fellowships. Of course, student-mentor relations typically extend beyond the time of supervision; students will keep publishing with their advisors after returning home. The resulting facilitation of exchanges of doctoral and postdoctoral students as well as funding of visiting or guest professor positions has certainly contributed to the sustained growth in international publications.

In addition to the facilitation of international collaboration by government and foundation policies, there has also been a strong increase in international academic mobility over the last

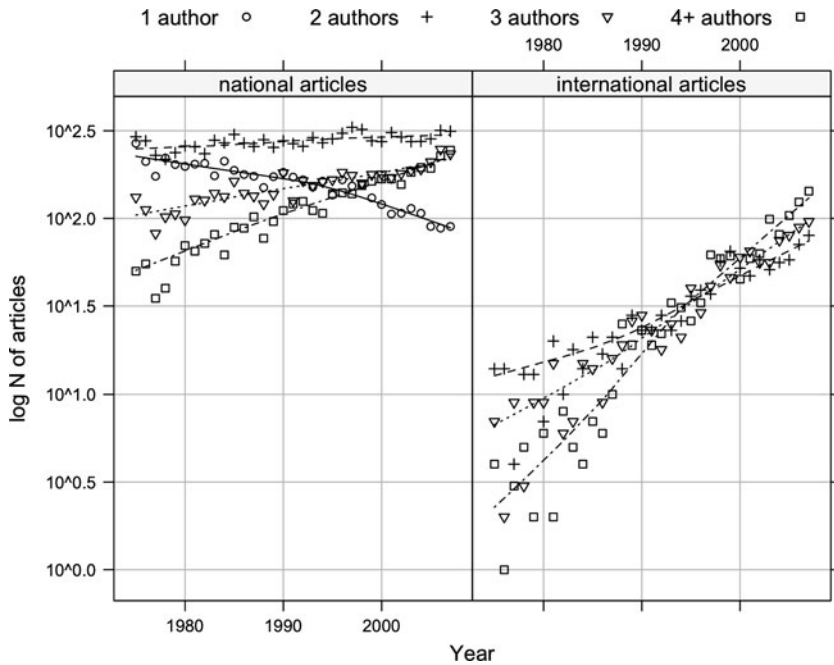


Fig. 5 Log number of national (left panel) and international articles (right panel) with 1, 2, 3, or a minimum of 4 authors per year (1975–2007). Single-author articles are by definition national articles; they decrease across the historical period. The growth of international articles is visible irrespective of the number of authors with larger and more similar growth rates than corresponding graphs for national articles

years, forced in part by a lack of adequate positions in some countries (for example Germany) and met by an expansion of the tertiary educational sector in others (for example the United Kingdom). This “brain drain”—as it is referred to—of usually above-average productive colleagues from one country to another does not sever established collaborations with research partners in the home country and contribute to the pool of international articles.

Of course, the positive connotations associated with international collaboration (i.e., that it is generally perceived to be good that people of different countries collaborate) should not be taken *prima facie* as hard evidence that research results published in international articles are in any way superior to those in national ones (see Katz and Martin 1997, for a discussion of the various facets of collaboration). Adams et al. (2007), with due precaution, report that international articles achieve a higher citation impact (corrected for age of publication) than UK publications. Fewer international than UK articles remain uncited and the entire distribution of citation impact is generally shifted further towards the high end for international than national articles. They conclude that their “data confirm the substantial advantage gained through international collaboration” (p. 21). Of course, such a result does not inform whether international articles achieve higher impact because of quality of research or because of larger social networks associated with them, to name two possible, but very different reasons.

The explanations for the rise in international collaboration sketched in the discussion are not exclusive of each other and there are probably other sources. At this point we present them as conjectures, but they could stimulate quantitative research into the history, sociology, and social psychology of psychological research. Irrespective of the relative

weights of mechanisms responsible for this pervasive change in publication patterns, international collaboration in psychology in particular and in science in general is obviously on a generally much welcome rise.

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