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Twenty-two years of psychological science in *Psychological Science*

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The journal *Psychological Science* (*PS*) has undergone various changes over 22 years since its birth in 1990. Analysis of Web of Science's records shows that the publication has increased in volume and collaborations between authors, and has become more international. Keyword analysis suggests the new role of neuroscience in contemporary psychology and indicates that the *PS* of today is more oriented than in the 1990s towards psychosocial and emotional issues as well as natural situations in our daily lives (ecological validity).

Keywords: Psychological science; Bibliometric study; Citations.

After little more than two decades of *Psychological Science* (*PS*), the main journal of the Association for Psychological Science (previously known as the American Psychological Society), we now have enough perspective to discern global patterns influencing contributions published in the journal. Since its first issue in 1990, *PS* has been an important journal in the field of psychology, placed among the top 10 multidisciplinary psychology journals worldwide in citation ranking and impact factor. Its influence and the fact that it covers the entire spectrum of scientific psychology make it a good reflection of the current state of contemporary psychological science.

METHOD

This study analysed the publications in *PS* recorded in Thomson Reuters' Social Sciences Citation Index (Institute for Scientific Information [ISI] Web of Knowledge, 2012) from 1990 to 2011 by means of EndNote X6 Software, 2012 and BibExcel (Persson, Danell, & Wiborg-Schneider, 2009) software. Conventional methods of bibliometric analysis were applied (Ball & Tunger, 2006; Van Raan, 1997). For most of the analyses, two 11-year periods (1990–2000, 2001–2011) were compared.

RESULTS AND DISCUSSION

Publishing in *PS*

A total of 2634 articles (Field = Document Type) were extracted from the Web of Science (Source = Psychological Science; Years = 1990–2011). The yearly distribution of articles shows an important rise from a subtotal of 734 articles (66.7 articles/year) in the 1990–2000 period to 1900 articles (172.7 articles/year) in the 2001–2011 period.

Collaboration among researchers also increased. Table 1 shows the distribution of articles according to the number of authors per article. In the first period, a quarter were written by a single author, whereas in the second period only 4.4% were single-author papers, and the proportion of works written by three or more authors increased noticeably. On average, the collaboration index changed from 2.50 authors/article in 1990–2000 to 3.21 authors/article in 2001–2011. The geographical origin of authors also changed at the turn of the century, becoming relatively less American and more international (Table 2). The percentage of contributions from the United States of America (USA) fell from 78.9 to 54.1%, while other countries increased in relative terms. For example, the striking increase in Dutch contributions from 5 to 125

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TABLE 1
Number of authors per article in *Psychological Science*.

	No. of articles (%)	
No. of authors/article	*1990–2000*	*2001–2011*
1	182 (24.8)	84 (4.4)
2	263 (35.8)	653 (34.4)
3	163 (22.2)	548 (28.8)
4	74 (10.1)	336 (17.7)
5	30 (4.1)	138 (7.3)
≥6	22 (3.0)	141 (7.4)
Total	734	1900
Mean No. of authors/article[a]	2.50	3.21

[a]The mean was calculated with all nominal values for ≥ 6 authors per article.

TABLE 2
Distribution of authors' addresses by country in *Psychological Science*

1990–2000		*2001–2011*	
USA	649 (78.9)[a]	USA	1356 (54.1)
Canada	58 (7.0)	UK	229 (9.1)
UK	31 (3.8)	Canada	226 (9.0)
Germany	12 (1.5)	The Netherlands	125 (5.0)
Australia	11 (1.3)	Germany	118 (4.7)
France	11 (1.3)	France	65 (2.6)
Israel	6 (0.7)	Australia	58 (2.3)
New Zealand	6 (0.7)	Italy	49 (2.0)
The Netherlands	5 (0.6)	Israel	46 (1.8)
Sweden	5 (0.6)	Belgium	31 (1.2)
USSR/Russia	5 (0.6)	China	25 (1.0)
China	4 (0.5)	Switzerland	25 (1.0)
Spain	4 (0.5)	Japan	23 (0.9)
Italy	3 (0.4)	Spain	19 (0.8)
Switzerland	3 (0.4)	New Zealand	14 (0.6)
Others	10 (1.2)	Sweden	13 (0.5)
		Others	85 (3.4)

Note. Duplicates were eliminated; If two or more authors of the same article belonged to the same country, they were computed as one.
[a]Percentages are in parentheses.

contributions is remarkable. Overall, contributions from European countries have been on the rise, a phenomenon that was also observed in the journal *Science* (González-Alvarez, 2012).

Internationality within the authors of a given paper increased notably. During 1990–2000 only 11.6% of the multi-authored articles were written by authors from more than one country, whereas this percentage has more than doubled (24.7%) in 2001–2011. This trend has been consistent: the Pearson correlation between the year of publication and the percentage of international papers was 0.85, $p = .0000005$ (.48, .87; confidence interval at 95%). Given the problems associated with Pearson's correlations (Rousselet & Pernet, 2012), we included a scatterplot (Figure 1) showing this relationship.

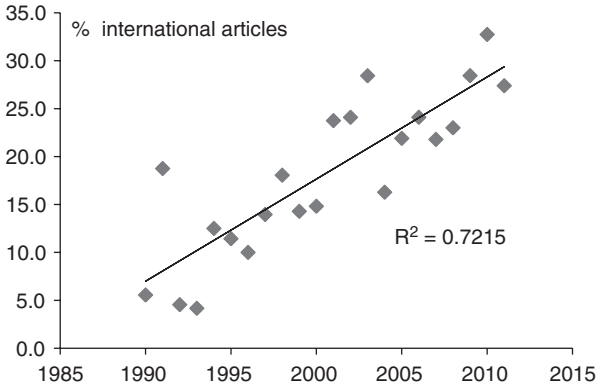

Figure 1. The plot shows the correlation ($r = .85$; $p = .0000005$) and regression line between the year of publication and the percentage of international articles published in *Psychological Science* (1990–2011).

TABLE 3
Productivity of authors publishing in *Psychological Science* (1990–2011)

Number of articles per author	*No. of authors (% of all authors)*
1	4211 (76.6)
2	754 (13.7)
3	267 (4.9)
4	124 (2.3)
5	60 (1.1)
6	32 (0.6)
7	18 (0.3)
8	12 (0.2)
9	11 (0.2)
10	4 (0.1)
11	2 (0.04)
12	1 (0.02)
13	1 (0.02)
14	1 (0.02)

Author productivity

PS publications are not evenly distributed among all authors. Lotka (1926) observed that the number of authors contributing to a journal is about $1/n^b$ (where b nearly equals 2) of those making one contribution. That means that the number of single-publication authors approximates 63% of all authors; in *PS* (Table 3), that figure is higher (76.6%). Our distribution fits Lotka's law when b is equal to 3.32 ($p[t] = .34$), which suggests that the distance between prolific and non-prolific authors is larger than expected. This general pattern also emerges in each period when analysed separately and is likely determined by the broad scope of the journal and its emphasis on new and unexpected findings, which does not favour the publication of subsequent small advances from the same author or following the same research line that is more typical in specialized journals. Consequently, the proportion of one-hit authors—or few-paper authors—is greater than in other journals.

TABLE 4
Most cited articles published in *Psychological Science* (2001–2011)

Times cited	*(2001–2011)*
554	Colcombe, S. & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *14*(2): 125–130.
370	Anderson, C. A. & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal and prosocial behavior: A meta-analytic review of the scientific literature. *12*(5): 353–359.
297	Turkheimer, E., Haley A., Waldron M., D'Onofrio B., & Gottesman, I. I. (2003). Socioeconomic status modifies heritability of IQ in young children. *14*(6): 623–628.
288	Alvarez, G. A. & Cavanagh, P. (2004). The capacity of visual short-term memory is set both by visual information load and by number of objects. *15*(2): 106–111.
280	Fredrickson, B. L. & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *13*(2): 172–175.
254	Cunningham, W. A., Preacher, K. J., & Banaji, M. R. (2001). Implicit attitude measures: Consistency, stability, and convergent validity. *12*(2): 163–170.
244	Lerner, J. S., R. M. Gonzalez, D. A. Small and B. Fischhoff (2003). Effects of fear and anger on perceived risks of terrorism: A national field experiment. *14*(2): 144–150.
232	Gasper, K. & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *13*(1): 34–40.
226	Luu, P., Tucker, D. M., Derryberry, D., Reed, M., & Poulsen C. (2003). Electrophysiological responses to errors and feedback in the process of action regulation. *14*(1): 47–53.
222	Roediger, H. L. & Karpicke, J. D. (2006). Test-enhanced learning—Taking memory tests improves long-term retention. *17*(3): 249–255.
214	Strayer, D. L. & Johnston, W. A. (2001). Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular telephone. *12*(6): 462–466.
213	Schupp, H. T., Junghofer, M., Weike, A. I., & Hamm, A. O. (2003). Emotional facilitation of sensory processing in the visual cortex. *14*(1): 7–13.
212	Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from experience and the effect of rare events in risky choice. *15*(8): 534–539.
207	Willis, J. & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *17*(7): 592–598.
206	Mather, M. & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *14*(5): 409–415.

Most cited papers

Every year, *PS* is ranked among the top 10 multidisciplinary psychology journals for impact factor by the ISI. The impact factor of a journal is the average number of citations received per paper published in that journal during the two preceding years; in the last years this indicator has received criticism as the only measure of journal importance because of its susceptibility to other variables (self-citations, editorial policies, etc.) (Nature, 2005). The last value for *PS* was 4.43, whereas the last aggregated impact factor for the category "Psychology, Multidisciplinary" in which *PS* is included was 1.87, and the median value was only 0.95 (JCR-Journal Citation Reports, 2011). However, which papers accumulated more citations over time? Table 4 lists the 15 most cited articles published in *PS* for the latter period. Their titles give us an idea of some of the issues receiving more attention.

PS citing

During the period of 1990–2011, *PS* emitted a relatively stable yearly average of 26–27 citations/article. The citing half-life of a journal is the median age of the articles that the journal cited in a given year; hence, half of the citations are to papers published within the half-life. The half-life of *PS* from 1997[1] to 2011 fluctuated between 7.9 and 8.9 years. Its last half-life (JCR-Journal Citation Reports, 2011) was 8.2 years, whereas the aggregated citing half-life for the category "*Psychology, Multidisciplinary*" in which *PS* is included was 9.5, that is, a little over a year older. The half-life index gives an approximation of the recency of the literature cited in scientific papers. *PS*'s index is situated between the typical index of theoretical or review journals (e.g., *Psychological Review* > 10 years, *Psychological Bulletin* = 9.9 years) and that of more specialized journals (e.g., *Social Cognitive and Affective Neuros*cience = 7.3 years) (JCR-Journal Citation Reports, 2011).

Keyword analysis

For each of the 1990–2000 and 2001–2011 periods, we extracted the keywords of every article published in *PS* (Field = *KeyWord Plus* of Web of Science[2]) and

[1]Thomson Reuters does not have citing half-life data before 1997.

[2]KeyWords Plus are index terms created by Thomson Reuters that are derived from the titles of articles cited by the author of the article being indexed. According to Thomson Reuters, KeyWords Plus augments traditional keyword or title retrieval.

TABLE 5
Most repeated keywords in articles published in *Psychological Science*[a]

%	*1991–2000*[b] *(n = 2646)*	*2001–2011 (n = 11,544)*
1–5	Memory (50); perception (43); attention (33)	Perception (217); attention (135); memory (133)
6–10	Recognition (33); information (31); model (24); behaviour (20); activation (18); language (18)	Information (132); behaviour (118); model (115); recognition (109); activation (88); performance (87); *cortex* (75)
11–15	Representation (18); retrieval (18); children (17); discrimination (16); search (16); recall (15); performance (14); similarity (14)	Children (73); mechanisms (72); *brain* (69); responses (62); task (60); language (57); cognition (53); *self* (51)
16–20	*Cortex* (13); judgement (13); objects (13); task (13); *brain* (12); identification (12); models (12); acquisition (11); choice (11); judgments (11); mechanisms (11)	*Emotion* (51); discrimination (48); time (46); representation (46); stimuli (44); experience (44); judgements (43); *inhibition* (42); knowledge (41); *vision* (41); humans (39); *infants* (39); *working memory* (38); objects (38)
21–25	Retention (11); stimuli (11); classification (10); humans (10); knowledge (10); time (10); features (9); *infants* (9); mood (9); organization (9); personality (9); rats (9); words (9); access (8)	Acquisition (38); choice (37); recall (37); system (35); *stress* (35); *fMRI* (35); identification (35); *attitudes* (34); search (34); mind (34); *risk* (34); *individual differences* (33); integration (32), personality (32); *potentials* (32); events (31); judgement (31); categorization (31)
26–30	Age (8); awareness (8); categorization (8); context (8); motivation (8); recognition memory (8); *potentials* (8); systems (8); comprehension (7); depression (7); integration (7); intelligence (7); invariance (7); lesions (7); motion (7); responses (7); selective attention (7); *self* (7); speech (7)	Retrieval (31); representations (31); models (29); *faces* (29); depression (29); capacity (29); *decision making* (29); orientation (28); motion (28); *meta-analysis* (27); cues (27); age (27); motivation (27); adults (26); life (26); visual attention (26); *women* (26); *shape* (26); context (25); words (25); similarity (25)
31–35	Accuracy (6); achievement (6); cognitive development (6); colour (6); events (6); frequency (6); illusions (6); *individual differences* (6); mental rotation (6); orientation (6); pictures (6); psychology (6); *risk* (6); selection (6); twin (6); visual search (6); amnesia (5); apparent motion (5); cognition (5); *faces* (5); implicit memory (5); location (5); locus (5)	Psychology (25); bias (25); interference (25); organization (24); *health* (24); *prejudice* (24); *amygdala* (24); perspective (24); pictures (23); systems (22); mood (22); visual search (22); intelligence (22); *eye movements* (22); awareness (22); *stereotypes* (22); *anxiety* (21); scale (21); *facial expressions* (21); *self-esteem* (21); *fear* (20); features (20); sensitivity (20); *short-term memory* (19); ability (19); selection (19)

[a]Terms that advanced in position in 2001–2011 (or were absent in 1991–2000) are in italics. Terms that descended in position in 2001–2011 (or were absent in that period) are underlined.
[b]Records of articles from 1990 did not include keywords.

computed them using BibExcel software. Table 5 shows the most repeated keywords for each period in descending order, comprising 35% of total occurrences (2646 in 1991–2000; 11,544 in 2001–2011). The keywords have been distributed according to this percentage for comparative purposes. To identify changes in research focus, terms that clearly advanced in position in the second period or were absent in the first period were indicated in italics, and terms that descended in position or were absent in the second period were underlined. For both cases, the most informative or less ambiguous terms were selected.

In both periods, 5% of all keywords corresponded to *memory*, *perception* and *attention*. However, in the second period, keywords related to some research topics, such as *representation*, *discrimination*, *identification*, *recall, language* and *comprehension*, descended in position in relative terms. On the contrary, other keywords appeared or advanced in rank during the 2001–2011 period. Neuroanatomical structures such as *cortex* or *brain* were clearly among the most repeated keywords of this period, and some additional neuroanatomical terms arised such as *amygdala*. Particularly, the keyword *fMRI* (functional magnetic resonance imaging, that is, a neuroimaging technique that measures brain activity by detecting changes in blood flow linked to mental functions and that is increasingly applied in psychological research) appears 35 times in *PS* articles during the second period compared to a single mention in the 1990s. The fact that these keywords are frequently included in the second period is an expression of the new role of neuroscience in contemporary psychology in which the brain is receiving a massive amount of attention (Sciolino, 2011). A keyword that has experienced a significant increase in frequency has been *emotion*, which escalated from 4 references in the 1990s to 51 in the next decade, an indicator of the relevance of emotion research in current psychological science. Psychosocial studies have also gained importance with frequent terms related to this field (i.e., *attitudes*, *prejudice*, *stereotypes* and *self-esteem* as socio-psychological constructs; *decision-making* and *risk*, which are typically associated with social contexts). Studies about *individual differences*, *women*, *infants*, *health*, *facial expressions*, *self*, *stress*, *anxiety* and *fear* have gained strength as psychology published in *PS* seems to have become more oriented towards issues with more ecological validity and proximity to natural situations in our daily lives. This emphasis

on ecological validity is corroborated if we examine some of the issues addressed in the most cited papers published in *PS* during the 2000s (Table 5): the relevance of fitness on cognitive functions in older adults; effects of violent video games on aggressive behaviour; positive emotions and well-being; the perceived risk of terrorism; research on driving and conversing on a cellular phone; first impressions of facial expressions; and experiments with facial emotions. Advancements in technology drive experimental work with use of more complete records of *event-related potentials* or more portable *eye-movement* recording devices; and *faces* has become an important stimulus in perception and emotion research, in part because of the developments in image morphing offered by computer software over recent years.

In summary, this analysis suggests that PS has become more international in the last decade and increasingly oriented towards neuroscience, psychosocial and emotional issues as well as natural situations in our daily lives, that is, emphasizing the importance of the ecological validity.

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