Mapping of neuroscience research: a quantitative analysis of publications output of China, 1999-2008

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ABSTRACT

Background: Neuroscience is one of the most active research fields in many countries including China since 1970. The Chinese neuroscientists are playing an ever growing and important role in IBRO activities for the development of worldwide cooperation in Brain research. Purpose: The main objective of this study is to analyze the research performance of China in neurosciences in national and global context, as reflected in its publication output during 1999-2008. Methods: This study is based on the Chinese publication data in neurosciences retrieved from the Scopus Citation database for the 10 years (1999-2008). Several parameters including total research output, its growth, rank and global publication share, citation impact, share of international collaborative papers and major collaborative partner countries and patterns of research communication in most productive journals were studied. Results: China's world ranking improved to 8th position in 2008. The cumulative publication output of China accounts for 39.69 % share of international collaborative papers during 1999-2008. Chinese authors in neuroscience field together contributed 794 papers, with an average of 49.63 papers per author. Conclusion: The top 49 highly cited papers in neurosciences from China had scored higher impact with 126.73 citations per paper. These 49 high-cited papers have appeared in 25 journals and are affiliated to 32 Chinese institutions.

Introduction

Neuroscience is one of the most active research fields in many countries including China, which is an economically and scientifically emerging country with rapid developments occurring since 1970. Among the biological sciences at large, neuroscience is one of the most advanced fields in China.

Neurosciences as a distinct discipline or research program have been a rather recent event in most Chinese universities, research institutes and other organizations. However, the last few years have witnessed increased funding and an improved research environment for neurosciences in China, both of which facilitated an influx of Chinese neuroscientists trained abroad.

A recent team members from International Brain Research Organization's (IBRO) visited to neuroscience centres in China and later termed the country as 'The Chinese Neuroscience Dragon'. The neuroscience community is growing fast in China. In several Institutes in Beijing, Xi'an, Hangzhou and Shanghai, neuroscientists are playing an active and leading roles in the development of neuroscience in the country and a number of centers of excellence have been recently established. The Chinese neuroscientists are playing an ever growing and important role in IBRO activities for the development of worldwide cooperation in brain research. For the growth of neuroscience in China, a unique China-Australian collaboration in neurosciences has been formed between Queensland Brain Institute (QBI) and the Institute of Biophysics, Chinese Academy of Sciences.

Much of the progress in neurosciences has been driven by small group of foreign trained scientists who have paired up with Institutes in China. Neurosciences growth story in Beijing and Shanghai is largely as a result of dedication and hard work of a few prominent individuals, but Institutes in Chinese provinces have still a long way to go to establish neurosciences programs and centers.

A few quantitative studies analyzing neuroscience literature in some countries have been carried out in the past. Braun et al.¹ analyzed the characteristics of publication activity and co-authorship in world neurosciences literature. Evaluation of country research output in neurosciences have been carried out on Europe¹² (Mela & Mancardi, 2002) (Robert,2006), Spain¹³ (Lopez-Munoz, 1996) (Gomez, 1990), Italy¹⁴ (Berardelli, 2005), Sweden¹⁵ (Glanzel, 2003), China¹⁶ (Xu, 2003) (Han, 2008), and Cuba¹⁷ (Dorta-Contreras, 2008) by different scholars from time to time. The main objective of this study is to analyze the research performance of China in neurosciences in national and global context, as reflected in its publication output during 1999-2008. In particular, the study focuses on the following objectives: (i) To study the Chinese research output, its growth, rank and global publication share and impact, (ii) To study the patterns of international collaboration, (iii) To study the publication productivity and impact of leading institutions of China, (iv) To study the characteristics of prolific authors and high cited-papers, and (v) To study the patterns of research communication in most productive journals.

Methods

This study is based on the Chinese publication data in neurosciences retrieved from the Scopus Citation database for the last 10 years (1999-2008). Three-year citations window has been used for counting the citations and for accessing the impact of Chinese research output, which included leading Chinese institutions and authors.

Results

Global Publication Share and Rank

The global publication shares of the top 26 countries varies from

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100% of the total publications by China. The publication output of China increased from 22% in 1999 to 39% in 2008, which shows that China is a fast rising player in the field of neuroscience.
0.84% to 36.13% during 1999-2008. The United States tops the list with global publication share of 36.13% and holds first rank during 1999-08, followed by United Kingdom (10.92%, 2nd rank), Germany (8.77%, 3rd rank), Japan (8.09%, 4th rank), Canada (5.71%, 5th rank), France (5.46%, 6th rank) and Italy (5.24%, 7th rank). Netherlands, Australia, Spain, Sweden and China ranks between 8th-12th position (with their global publication share ranging from 2% to 3%). The countries that rank between 13th and 20th positions include Switzerland, Columbia, Brazil, Israel, Belgium, South Korea, Finland and Turkey with their global publication share ranging from 1% to 2%. The next six countries (India, Austria, Denmark, Poland, Russia and Taiwan) rank from 21st to 26th positions with their global share less than 1% (Table 1).

Among developed countries, those that has shown decline in publication share from the year 1999 to the year 2008 are United States, United Kingdom, Germany, Japan, France, Sweden, Finland and Russia. In contrast, developed countries that have shown rise in their publication share during the same period are Canada, Netherlands, Australia, Spain, Switzerland, Belgium, Finland, Turkey, Austria, Denmark and Poland. In contrast, most developing countries (except Columbia) has shown rise in their publication share from 1999 to 2008: China by 3.93%, South Korea by 1.42%, Brazil by 1.29%, India by 0.63%, Taiwan by 0.60% and Israel by 0.28% (Table 1).

China ranks at 12th position among the top 26 countries in Neurology, with its global publication share of 2.03% during 1999-08. Brazil, South Korea and India ranks at 15th, 18th and 26th position, with global publication share of 1.74%, 1.24% and 0.99% during 1999-08. China's global share has increased from 0.86% to 4.79% and also its world ranking from 21st to 8th from 1999 to 2008. In comparison, Brazil, South Korea and India's global publication share increased from 1.09% to 2.38%, 0.57% to 1.99% and from 0.72% to 1.35% from 1999 to 2008 and their global ranking increased from 15th to 12th, 18th to 15th and from 23rd to 19th (Table 1).

China's publication output in Neurosciences

China's total cumulative publication output during 1999-2008 consists of 9184 papers, with average number of papers per year as 918. Compared to China, the publication output of Brazil, South Korea and India during the same period consists of 7850 papers, 5625 papers and 4503 papers, with average number of papers per year as 785, 562 and 450 respectively. The cumulative number of publications of China increased from 2182 papers in 1999 to 2182 papers in 2008.

Table 1 : Global publication output, publication share and rank of top 26 most productive countries in Neurosciences

| S.No. | Country    | No. of Papers | % Share of Papers | Rank |
|-------|------------|---------------|-------------------|------|
| 1     | USA        | 163055        | 36.13             | 1    |
| 2     | U.K.       | 49283         | 10.92             | 2    |
| 3     | Germany    | 39594         | 8.77              | 3    |
| 4     | Japan      | 36532         | 8.09              | 4    |
| 5     | Canada     | 25786         | 5.71              | 5    |
| 6     | France     | 24642         | 5.46              | 6    |
| 7     | Italy      | 23634         | 5.24              | 7    |
| 8     | Netherlands| 13716         | 3.04              | 8    |
| 9     | Australia  | 13098         | 2.90              | 9    |
| 10    | Spain      | 12044         | 2.67              | 10   |
| 11    | Sweden     | 9282          | 2.06              | 11   |
| 12    | China      | 9184          | 2.03              | 12   |
| 13    | Switzerland| 8699          | 1.93              | 13   |
| 14    | Columbia   | 7852          | 1.74              | 14   |
| 15    | Brazil     | 7850          | 1.74              | 15   |
| 16    | Israel     | 7484          | 1.66              | 16   |
| 17    | Belgium    | 5636          | 1.25              | 17   |
| 18    | South Korea| 5580          | 1.24              | 18   |
| 19    | Finland    | 4508          | 1.01              | 19   |
| 20    | Turkey     | 4540          | 1.00              | 20   |
| 21    | India      | 4503          | 0.99              | 21   |
| 22    | Austria    | 4378          | 0.97              | 22   |
| 23    | Denmark    | 4302          | 0.95              | 23   |
| 24    | Poland     | 4136          | 0.92              | 24   |
| 25    | Russia     | 3825          | 0.85              | 25   |
In terms of impact and quality, the average citations per paper registered by China's publication output during 1999-06 were 7.24. In comparison, South Korea publications have registered a comparative higher impact of 8.29 than China, followed by Brazil (5.99) and India (4.21) with comparative less impact for their publications during the same period. The average citations per paper for China's cumulative publications decreased from 7.70 in 1999-02 to 7.24 in 2003-06. In comparison, the average citations per paper for cumulative publications of Brazil, South Korea and India decreased from 6.27 to 5.99, 8.61 to 8.29 and from 4.54 to 4.21 from 1999-02 to 2003-06 (Table 2).

Considering the contribution of collaborative partners in China's publication output, 19 countries were found to publish more International collaborative share in China's publication output. Based on the publication data, the total cumulative International collaborative papers of China consist of 3645 papers, which accounts for 39.69% share in the cumulative output of China in Neurosciences during 1999-08. In comparison, South Korea's International collaborative papers share in their cumulative publication output during 1999-08 was 28.18% share (with 1585 collaborative papers), followed by Brazil with 24.09% (with 1891 collaborative papers) and India with 17.34% share (with 781 collaborative papers) (Table 3).

China witnessed a marginal decrease in the share of international collaborative papers from 40.74% in 1999-03 to 39.36% in 2004-08. In comparison, the international collaborative publications share of Brazil and India has increased from 22.78% to 24.84% and from 13.59% to 19.70%, as against decrease from 28.35% to 28.09% in case of South Korea from 1999-03 to 2004-08 (Table 3).

### Table 2: Publication output and citations received by China, Brazil, South Korea and India Papers in Neurosciences, 1999-08

| Year   | China  | Brazil  | South Korea | India  |
|--------|--------|---------|-------------|--------|
|        | TP     | TC      | ACPP        | TP     | TC      | ACPP        | TP     | TC      | ACPP        |
| 1999   | 337    | 1849    | 5.49        | 429    | 2008    | 4.68        | 224    | 1934    | 8.63        | 284    | 700     | 2.46        |
| 2000   | 386    | 2343    | 6.07        | 527    | 3212    | 6.09        | 312    | 2329    | 7.46        | 319    | 1416    | 4.44        |
| 2001   | 361    | 2128    | 5.89        | 533    | 2949    | 5.53        | 336    | 2503    | 7.45        | 312    | 1308    | 4.19        |
| 2002   | 460    | 3165    | 6.88        | 653    | 3746    | 5.74        | 391    | 2928    | 7.49        | 359    | 1308    | 3.64        |
| 2003   | 638    | 4640    | 7.27        | 729    | 4799    | 6.58        | 525    | 4313    | 8.22        | 463    | 1694    | 3.66        |
| 2004   | 789    | 6267    | 7.94        | 733    | 4644    | 6.34        | 554    | 4999    | 9.02        | 411    | 1888    | 4.59        |
| 2005   | 942    | 7957    | 8.45        | 872    | 5589    | 6.41        | 646    | 5994    | 9.28        | 464    | 2349    | 5.06        |
| 2006   | 1284   | 9282    | 7.23        | 1020   | 6013    | 5.90        | 772    | 5802    | 7.52        | 546    | 2626    | 4.81        |
| 2007   | 1453   | 1097    | 7.94        | 1257   | 1051    | 7.15        |        |         |             |        |         |             |
| 2008   | 2534   | 1515    | 6.95        |        |         |             |        |         |             |        |         |             |
| 99-03  | 2182   |         |             |        |         |             |        |         |             |        |         |             |
| 04-08  | 7002   |         |             |        |         |             |        |         |             |        |         |             |
| 99-08  | 9184   |         |             |        |         |             |        |         |             |        |         |             |

TP = Total Paper; TC = Total Citations; ACPP = Average Citation per Paper

### Table 3: Number and share of International papers of China, Brazil, South Korea and India.

| Year | China  | Brazil  | South Korea | India  |
|------|--------|---------|-------------|--------|
|      | TP     | TICP    | %TICP       | TP     | TICP    | %TICP       |
| 1999-03 | 2182   | 889     | 40.74       | 1999-03 | 2871   | 654        |
| 2004-08 | 7002   | 2756    | 39.36       | 2004-08 | 4979   | 1237       |
| 1999-08 | 9184   | 3645    | 39.69       | 1999-08 | 7850   | 1891       |

TP = Total Paper; TICP = Total International Collaborative Papers
than 20 collaborative papers with China during 1999-2008 and they are considered as major collaborative partners. United States is the largest collaborating partner during 1999-08, by contributing 45.38% share in China's total international collaborative papers in Neurosciences during 1999-08, followed by Japan (13.09% share), Taiwan, Canada, Germany, Sweden, and Australia, (between 3.21% to 6.36% share), France, UK, Netherlands and Singapore, (between 2% to 3%), South Korea, Denmark, Italy, Columbia and Switzerland (between 1 to 2% share). On analyzing the shift in International collaborative publications share of these countries from 1999-03 to 2004-08, it was found that the share of United States have increased by 4.82%, followed by Canada (2.6%), Germany (1.57%) South Korea (1.24%), Singapore (1.04%) and Australia (0.82%), while the share of all other collaborating countries have decreased by 3.67% in Japan, followed by Sweden (3.07%), Taiwan (1.85%), Denmark(1.09%), and U.K (0.27%)(Table 4).

Research profile of most productive Chinese Institutions

The top 15 Chinese most productive Institutions in Neurosciences have published more than 170 papers during 1999-2008. The list of these Institutions along with their research output, percentage share, growth rate, number of collaborative papers, citations and h index value registered is presented in Table 5 & 6. These 15 institutions together contributed 57.61% share (with 5291 papers) in the cumulative publication output of China in Neurosciences, with an average of 352.73 papers per Institution. Only 4 institutions registered the higher publications output than the group average. These are Chinese University of Hong Kong (with 831 papers and 9.05% share), Peking University (with 669 papers and 7.28% share), The University of Hong Kong (with 628 papers and 6.84% share), and Fudan University (with 466 papers and 5.07% share).

Considering the growth rate of these 15 Institutes' publications from 1999-2003 to 2004-2008, the overall growth rate was found to be 179.01%. Nine institutions have achieved the higher growth rate than the group average. These are Shanghai Jiaotong University, Shanghai with a growth rate 1442.11%, followed by Sun Yat Sen University, Guangzhou (with 1220% growth rate), China Medical University, Shenyang (with 870% growth rate), Capital Medical University, Beijing (with 760.61% growth rate), Zhejiang University, Hangzhou (with 659.10% growth rate), Sichuan University, Chengdu (with 600% growth rate), Huazhong Univ. of Science & Technology, Wuhan (with 490.91% growth rate), Peking University (with 284.78% growth rate) and Fudan Univ., Shanghai(with 194.92% growth rate).

The average citation per paper received by the total papers of these 15 most productive Institutions is 4.08. Among these 15 Institutions, Shanghai Inst. for Biological Sciences, Shanghai scored the highest impact with 5.40 citations per paper, followed by The University of Hong Kong, China (with 4.67 citations per paper), Sun Yat-Sen University, Guangzhou (with 4.61 citations per paper), Peking University and Fudan University (with 4.50 citations per paper each), Huazhong University of Science & Technology, Wuhan (with 4.38 citations per paper), Univ. of Science & Technology, Hefei (with 4.37 citations per paper) and Chinese University of Hong Kong (with 4.14 citations per paper).

Considering the number and share in the form of international
collaborative papers, these Institutions together contributed 1979 International collaborative papers, with an average share of 37.40% in total papers by these Institutions. Only six Institutions have scored more than the average share of International collaboration of all 15 Institutions. They are Zhejiang University, Hangzhou with 53.44% share of International collaborative papers), followed by The University of Hong Kong, China (with 52.71% share), Sichuan University, Chengdu (with 48.86% share), China Medical University, Shenyang (with 46.95% share), Shanghai Inst. for Biological Sciences, Shanghai (with 46.26% share), and Peking University (with 40.66% share).

The average h-index value of these 15 most productive institutions was 23. The six institutions have registered higher h-index value than group average. These are Chinese University of Hong Kong and The University of Hong Kong (each with h-index value of 38), followed by Peking University, Beijing (32), Fudan Univ., Shanghai (30), The Fourth Military Medical Univ., Xi'an (25) and Shanghai Inst. for Biological Sciences, Shanghai (24).

Most prolific authors in Neurosciences research in China Considering the prominent authors in Neurosciences research in China, 16 Chinese authors are identified as productive ones, who have published 39 and above papers during 1999-2008. Of these 16 authors, 3 are affiliated to Peking University, Beijing, 2 each with Fourth Military Medical Univ., Xi'an and Fudan University, Shanghai, and 1 each to other institutions. (Table 7). These 16 authors together contributed 794 papers, accounting

### Table 5: Percentage share and growth rate of top institutions of China in Neuroscience during 1999-2008

| Institution name                                      | TP    | TC     | ACPP | TICP  | % Share of TICP | Growth Rate |
|-------------------------------------------------------|-------|--------|------|-------|-----------------|-------------|
| Chinese Univ. of Hong Kong, Hong Kong China          | 289   | 542    | 831  | 9.05  | 87.54           |             |
| Peking Univ., Beijing                                 | 138   | 531    | 669  | 7.28  | 284.78          |             |
| The University of Hong Kong, Hong Kong, China         | 242   | 386    | 628  | 6.84  | 59.50           |             |
| Fudan Univ., Shanghai                                 | 118   | 348    | 466  | 5.07  | 194.92          |             |
| Capital Medical Univ. China, Beijing                  | 33    | 284    | 317  | 3.45  | 760.61          |             |
| Shanghai Jiaotong Univ., Shanghai                     | 19    | 293    | 312  | 3.40  | 1442.11         |             |
| The Fourth Military Medical Univ., Xi'an              | 142   | 160    | 302  | 3.29  | 12.68           |             |
| Zongshan Ophthalmic Center, Guangzhou                 | 172   | 122    | 294  | 3.20  | -29.07          |             |
| Shanghai Inst. for Biological Sc. Chinese Acdemy of Sc., Shanghai | 68    | 179    | 247  | 2.69  | 163.24          |             |
| Huazhong Univ. of Sc. & Tech., Wuhan                  | 33    | 195    | 228  | 2.48  | 490.91          |             |
| China Medical Univ. Shenyang, Shenyang                | 20    | 194    | 214  | 2.33  | 870.00          |             |
| Sun Yat-Sen Univ., Guangzhou                          | 15    | 198    | 213  | 2.32  | 1220.00         |             |
| Univ. of Sc. & Technology, Hefei                       | 63    | 142    | 205  | 2.23  | 125.40          |             |
| Zhejiang Univ., Hangzhou                              | 22    | 167    | 189  | 2.06  | 659.10          |             |
| Sichuan Univ., Chengdu                                | 22    | 154    | 176  | 1.92  | 600.00          |             |

### Table 6: Research output, impact, International collaborative papers share and h-index of top institutions of China in Neurosciences during 1999-2008

| S.No. | Name of Institution          | TP     | TC      | ACPP | TICP  | % Share of TICP | h-index |
|-------|------------------------------|--------|---------|------|-------|-----------------|---------|
| 1     | Chinese Univ. of Hong Kong, Hong Kong China | 831    | 3442    | 4.14 | 309   | 37.18           | 38      |
| 2     | Peking University, Beijing   | 669    | 3012    | 4.50 | 272   | 40.66           | 32      |
| 3     | The University of Hong Kong, Hong Kong, China | 628    | 2932    | 4.67 | 331   | 52.71           | 38      |
| 4     | Fudan Univ., Shanghai       | 466    | 2098    | 4.50 | 158   | 33.91           | 22      |
| 5     | Capital Medical Univ. of China, Beijing | 317    | 1197    | 3.78 | 99    | 31.23           | 22      |
| 6     | Shanghai Jiaotong Univ., Shanghai | 312    | 1267    | 4.06 | 88    | 28.21           | 21      |
| 7     | The Fourth Military Medical Univ., Xi'an | 302    | 1088    | 3.60 | 106   | 35.10           | 25      |
| 8     | Zhongshan Ophthalmic Center, Guangzhou | 294    | 199     | 0.68 | 29    | 9.86            | 9       |
| 9     | Shanghai Inst. for Biological Sciences, Shanghai | 247    | 1333    | 5.40 | 61    | 24.70           | 24      |
| 10    | Huazhong Univ. of Sc. & Tech., Wuhan | 228    | 1000    | 4.38 | 81    | 35.53           | 21      |
| 11    | China Medical Univ. Shenyang, Shenyang | 214    | 797     | 3.52 | 99    | 46.26           | 16      |
| 12    | Sun Yat-Sen Univ., Guangzhou | 213    | 982     | 4.61 | 100   | 46.95           | 15      |
| 13    | Univ. of Sc. & Technology, Hefei | 205    | 895     | 4.37 | 59    | 28.78           | 22      |
| 14    | Zhejiang Univ., Hangzhou    | 189    | 734     | 3.88 | 101   | 53.44           | 16      |
| 15    | Sichuan Univ., Chengdu      | 176    | 637     | 3.62 | 86    | 48.86           | 16      |

TP = Total Papers; TC = Total Citations; ACPP = Average Citations Per Paper
for 8.65% share in the cumulative publication output of China, with an average of 49.63 papers per author. However, the contribution of these authors witnessed decrease in their publication share from 13.66% in 1999-2003 to 7.08% in 2004-08. Seven Chinese authors have published higher number of papers than the group average (49.63 papers per author). These are L.Y. He with 74 papers during 1999-08), followed by Q.Y. Li (with 64 papers), T.L. Xu (with 58 papers), L.C. Yu (with 56 papers), J.S. Han (with 55 papers), G. Ju (with 53 papers) and G.C. Wu (with 52 papers) (Table 7).

These combined publications output of these 16 most productive Chinese authors have received an average citations per paper of 4.75 citations per paper during 1999-2008, which rose from 3.94 citations per paper in 1999-2003 to 5.23 in 2004-2008. Eight Chinese authors have scored higher citations average per paper than the average citation per paper of all 16 authors (4.75 citations per paper). Among these authors, T. Jiang had registered the highest average citations per paper of 12.15, followed by L.Y. He (with 6.24 citations per paper), T.L. Xu (with 6.15 citations per paper), T.Y. Li (with 5.90 citations per paper), J.S. Han (with 5.65 citations per paper), R.Q. Wang (with 5.49 citations per paper), J.N. Zhou (with 4.93 citations per paper) and S. Han (with 4.90 citations per paper) (Table 7).

The average h-index value of these authors is 12.75. Ten authors registered higher h-index value than group average. The highest h-index value (16) is achieved by Jisheng Sheng Han and Lin Yan He and Tianzi Jian, followed by Long Chuan Yu and Tiangle L. Xu (each with h-index value of 15), Y.Q. Li, Gen Cheng Wu, Gen Wu, Qiang Wang Rui, Jiang Ning Zhou and, Yu Feng Zhang (each with h-index value of 13) (Table 7).

Research communication profile of high productive journals

The top productive 21 Chinese and foreign Journals together contributed 54.20% share in the cumulative publication output of China in Neurosciences during 1999-2008. Of these 21 journals, only 4 journals are of Chinese origin contributing 8.83% share and 17 are International journals contributing 45.37% share in the total publication productivity of China in Neurosciences. The cumulative share of these journals showed decrease in its share from 54.20% in 1999-2003 to 44.62% in 2004-2008 (Table 8).

Research patterns of high cited papers

The characteristics of selected highly cited papers of China in Neurosciences were also evaluated in this section and the list of such high-cited papers is presented in Table 9. Based on publication output of China in this area, 49 papers are identified as highly cited ones, who have received citations (since their publications till 30 October 2009) from 90 to 216 during 1999-2009. Of these 49 papers, 41 appeared as articles, 6 as reviews, and 2 as short surveys. Of the 49 high-cited papers, 73.47% involve international collaboration (26 bilateral and 10 multilateral) and 6.12% national collaboration.

These 49 papers together received 6210 citations with an average of 126.73 citations per paper. Of these 49 papers, 7 papers are in citation range of 161-250, 26 papers in citations range of 101-160 and 16 papers in citations range of 90-100. The authors of these high cited papers are affiliated to 32 Chinese institutions including 5 papers each from Dalian Medical...
### Table 8: List of highly productive journals publishing papers of China in Neuroscience, 1999-2008.

| S. No. | Journal Name                                           | 1999-2008 | 1999-03 | 2004-08 |
|--------|--------------------------------------------------------|-----------|---------|---------|
| 1.     | Neuroscience Letters                                   | 751       | 206     | 545     |
| 2.     | Brain Research                                         | 582       | 179     | 403     |
| 3.     | Yan Ke Xue Bao Eye Science Yan Ke Xue Bao Bian Ji Bu   | 383       | 246     | 137     |
| 4.     | Neurocomputing                                         | 377       | 28      | 349     |
| 5.     | European Journal of Pharmacology                       | 367       | 86      | 281     |
| 6.     | Neural Regeneration Research                           | 314       | 0       | 314     |
| 7.     | Neuroreport                                            | 295       | 104     | 191     |
| 8.     | Neuroscience                                           | 251       | 68      | 183     |
| 9.     | Peptides                                               | 225       | 48      | 177     |
| 10.    | Neuroscience Bulletin                                  | 208       | 0       | 208     |
| 11.    | Journal of Neuroscience Research                       | 148       | 31      | 117     |
| 12.    | Journal of Neurochemistry                              | 136       | 24      | 112     |
| 13.    | Chinese Journal of Contemporary Neurology and Neurosurgery | 124       | 0       | 124     |
| 14.    | Journal of Neuroscience                                | 117       | 23      | 94      |
| 15.    | Neurochemical Research                                 | 114       | 20      | 166     |
| 16.    | Brain Research Bulletin                                | 107       | 36      | 71      |
| 17.    | European Journal of Neuroscience                       | 106       | 28      | 78      |
| 18.    | Neurological Research                                 | 99        | 11      | 88      |
| 19.    | Chinese Journal of Neuroscience                       | 96        | 49      | 47      |
| 20.    | Neuroscience Research                                 | 89        | 25      | 64      |
| 21.    | Regulatory Peptides                                   | 89        | 25      | 64      |
| Total  |                                                        | 4978      | 1237    | 3741    |

### Table 9: List of top 49 highly cited papers, 1999-2008

| Author          | Title                                                                 | Source title                  | Cited by | Affiliation                                                   | Collaboration |
|-----------------|------------------------------------------------------------------------|-------------------------------|----------|--------------------------------------------------------------|--------------|
| Gao H.-M., Jiang J., et al | Microglial activation-mediated delayed and progressive degeneration of rat nigral dopaminergic neurons: Relevance to Parkinson's disease | Journal of Neurochemistry, 2002, 81(6) | 216      | Dalian Medical University, Department of Physiology, Dalian, China | BC           |
| Chen Z., Sandercock P., et al | Indications for early aspirin use in acute ischemic stroke: A combined analysis of 40 000 randomized patients from the Chinese Acute Stroke Trial and the Int emational Stroke Trial | Stroke, 2000, 31(6) | 214      | Chinese Academy of Medical Sciences, Beijing, China          | BC           |
| Liao X., Chen G., Sanchez E.N. | Delay-dependent exponential stability analysis of delayed neural networks: An LMI approach | Neural Networks, 2002, 15(7) | 210      | Department of Computer Science and Engineering, Chongqing University, Chongqing | MC           |
| Feng R., Rampon C., et al | Deficient neurogenesis in forebrain-specific presenilin-1 knockout mice is associated with reduced clearance of hippocampal memory traces | Neuron, 2001, 32(5) | 189      | Shanghai Institute of Brain Functional Genomics, East China Normal University, Shanghai, China | MC           |
| George M.S., Nahas Z., et al | A controlled trial of daily left prefrontal cortex TMS for treating depression | Biological Psychiatry, 2000, 48(10) | 181      | Department of Psychiatry, Shangdong Medical University, Jinan, China | BC           |
| Armtten A.F.T., Li B.-M., et al | Neurobiology of executive functions: Catecholamine influences on prefrontal cortical functions | Biological Psychiatry, 2005, 57(11) | 178      | Institute of Neurobiology, Fudan University, Shanghai, China | BC           |
| Han J.-S. | Acupuncture: Neuropeptide release produced by electrical stimulation of different frequencies | Trends in Neurosciences, 2003, 26(1) | 162      | Neuroscience Research Institute, Peking University, 38 Xue Yuan Road, Beijing 100083, China | ZC           |
| Wemmie J.A., Chen J., et al | The acid-activated ion channel ASC contributes to synaptic plasticity, learning, and memory | Neuron, 2002, 34(3) | 160      | University of Science and Technology, Wuhan, China | BC           |
| Name                  | Title                                                                                   | Journal                                      | Year  | Authors                                                                 | Page | Institution                                      | Country |
|-----------------------|-----------------------------------------------------------------------------------------|----------------------------------------------|-------|-------------------------------------------------------------------------|------|--------------------------------------------------|
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University, Dalian and Institute of Neuroscience, Shanghai, 4 papers each form Fudan University, Shanghai and Fourth Military Medical university. Xi’an, 2 each from Peking University, Beijing, Univ of Science & Technology and Wuhan, Hunan University, Changsha and 1 paper each from 29 other Chinese institutions. These 49 high cited papers have appeared in 25 journals, including 8 in Neuron, 7 in Neural Networks, 5 in Journal of Neuroscience, 3 in Journal of Neurochemistry & Biological Psychiatry, 2 each in Trends in Neurosciences, Annals of Neurology and Nature Neuroscience and 1 paper each in 17 other journals.

**Conclusion**
China published 9184 papers in Neurosciences during 1999-08, compared to 7850 papers by Brazil, 5725 papers by South Korea and 4503 papers by India during the same period. China ranks at 12th position among the top 26 countries in Neurology, with its global publication share of 2.03% during 1999-08.
China, Brazil, South Korea and India ranks at 15th, 18th and 21st position, with global publication share of 1.74%, 1.24% and 0.99% during 1999-08. China witnessed rise in global publication share from 0.86% in 1999 to 4.79% in 2008. Correspondingly, China's world ranking improved from 21st position in 1999 to 8th position in 2008.

In terms of impact and quality, the average citations per paper registered by China's publication output during 1999-06 were 7.24. Compared to China, only South Korea publications have registered higher impact of 8.29 instead of Brazil (5.99) and India (4.21) for their publications during the same period.

The cumulative publication output of China accounts for 39.69% share of international collaborative papers during 1999-2008. China has shown the decrease in its share of internationally collaborative papers from 40.74% in 1999-2003 to 39.36% in 2004-2008. Among the collaborative countries, USA is the major collaborator with China during 1999-08, followed by Japan, Taiwan, Canada, Germany, Sweden, Australia, France, etc.

The cumulative publication output of 15 most productive institutions in China's total research output in Neuroscience during 1999-2008 was 5291 papers (57.61% of the China's total output in this field) with the growth rate of 179.01% for the papers published from 1999-2003 to 2004-2008. These 15 Institutions have registered an average impact of 4.08 citations per paper and an average h-index value of 23. They have contributed 37.40% share of international collaborative papers in their total publication output during 1999-08.

The 16 most productive Chinese authors in Neuroscience field together contributed 794 papers, with an average of 49.63 papers per author, received an average of 4.75 citations per paper and average h-index of 12.75 per author.

The total publication output of top 21 productive journals together contributed 54.20% share to the total publication output of China in Neurosciences during 1999-2008.

Of the 49 high-cited papers, 73.47% involve international collaboration (26 bilateral and 10 multilateral) and 6.12% national collaboration. The top 49 highly cited papers in Neurosciences from China had scored higher impact with 126.73 citations per paper. These 49 high-cited papers have appeared in 25 journals and are affiliated to 32 Chinese Institutions.

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