

Space Neuroscience Research Publication in Global: A Scientometric Analysis (1999-2012)

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Abstract - The present study is used to identify the pattern of publication, authorship, citations and secondary journal coverage in the hope such regularities can give an insight into the dynamics of the area under consideration. During 1999-2012 a total of 486 papers were published by the scientists in the field of space neuroscience research. The average Number of Publications produced per year was 34.7%. The highest number of publications 70 was produced in 2010. The most productive author is Rabinovich MI and Spence C with each 6 papers dealing with space neuroscience research and 1.2% of all papers published in this research field. The highest number of publication is at USA 199 (39.9%) and lowest number of publication is at UAE 1(0.2%).

Keywords: Scientometric Study, Neuroscience, Space, Bibliometric study, Citation Analysis, Total Local Citation Score, Total Global Citation Score, Total Cited Reference, united Arab Emirates

I. INTRODUCTION

Space neuroscience is a special area of space life sciences that seeks to understand the effects of space flight on the nervous system, and to use the microgravity environment of space to better understand how the nervous system functions under normal gravitational forces. In the past, space life sciences focused mainly on the health, safety and performance of the astronauts. Over the past decade, however, NASA Shuttle missions created new opportunities to develop the specialty called "space neuroscience," and to design Earth-based research to improve techniques and designs for conducting neuroscience experiments in space.

II. STATEMENT OF THE PROBLEM

The present study pointing out of analyzing the research output performance of space neuroscience in Global perspective. In academic and scientific work, publication means of communicating research, primarily of recognition

and reward and central social process in the Universities. Hence publication is a social norm in a public sense and serves as a tool for the betterment of the individuals. After the publication, it can be called as research and can be fixed or judged and acknowledged by the scientists in the society.

III. REVIEW OF LITERATURE

The analysis of the review of literature is the key focus of any research (R.Maheswaran, 2007). It enables to be aware of the past and current trends in any particular branch of research. Research on Scientometric study is the performance on space neuroscience has attracted the attention of various scholars, researchers, information scientists and library personals throughout the world (R.Maheswaran, 2008). Sagar, Anil; Kademani, B. S; Garg, R. G and Kumar, Vijai (2010) analyzed the Scientometric mapping of Tsunami publications [1]. The objective of the study was to perform a scientometric analysis of all Tsunami related publications as per the Scopus™ database during 1997-2008. A spurt in number of publications was observed after the Indonesia's tsunami occurred on 26 December 2004. Ming-Yueh Tsay and Yi-Jen Lin (2009) discuss the characteristics of transport phenomenon literature from 1900 to 2007 based on the Science Citation Index Expanded (SCI™ Expanded) database and its implication using two scientometric techniques, namely Bradford-Zipf's law and Lotka's law (R.Maheswaran, 2013). Kaliyaperumal, K and Natarajan, K (2009) have examined to focus on growth pattern as well as overall trend in literature output on retina during 2002-2007. Secondary data collection from a set of retrieved bibliographic records from the literature output in the field of retina from the CD-ROM sources of MEDLINE was studied. The paper also highlights the need of more

research in retina-related research. Kumar, Anil; Kademani, B. S and Kumar, Vijai (2008) argues that the growth and development of web-resources in INSPEC database during 1995-2005. A total of 18673 publications appeared in 171 web-resources contributed by the scientists in various areas of research: subject's wise, publications wise, country wise, language and document wise.

IV. PURPOSE OF THE STUDY

1. The present citation study is to understand the information and communication channels, in one of the multidisciplinary subject of space neuroscience published in articles from Journals; authors form book and papers from Conference Proceedings in 14 years that is from 1999 to 2012 ;
2. To examine the utility of tertiary sources like handbooks.

V. SCOPE OF THE STUDY

The study is to find out the information about the recent communication trends in the advancement of the field of Multidisciplinary subject a citation analysis "space neuroscience" and for this purpose, the study is based on articles in journals, authors published the books and papers published in conference proceedings published on space neuroscience subject from 1999 to 2012 using statistical techniques like histogram charts, bar charts etc.

VI. LIMITATIONS OF THE STUDY

- a) The study undertaken is limited to 14 years, i.e. 1999-2012;
- b) It is a small scale study, which may need to be indicated by the states;
- c) Studied only the Citation analysis of tertiary source of information;
- d) It is not included the citation analysis on patents.

VII. OBJECTIVES OF THE STUDY

The main objective of this study is to study the citation analysis of space neuroscience in respect of;

1. Number of articles published in journals;
2. Number of papers published in conference proceedings;
3. Determine the year-wise distribution of citations;
4. Study the use pattern of different type of documents cited;
5. Observe the year-wise publication of citations in

journals and their distribution;

6. Observe the Authors wise citation to the book.

VIII. DATA COLLECTION

The publications of space neuroscience are mostly in the form of primary Journals, Notes", Letters, reviews, Editorial-materials, Meeting-abstracts, Bibliographic-items and Discussions. The research papers published by web of science in the field of Science and Technology covered and index database were taken as the prime source for the present study. The bibliographical details of publications were entered in the catalogue cards. Finally the cards were arranged in different ways with a view to identify the research performance of faculty Members.

IX. RESULTS AND DISCUSSION

A. Degree of Collaboration

The authorship pattern analyzed to determine the percentage of single and multi-authorship is denoted in Table I. The extended of collaboration in research can be measured with the help of multi authored papers using in the formula given by subramaniyam (1982).

$$\text{Degree of collaboration } C = \frac{Nm}{Nm + Ns}$$

C= Degree of collaboration

Nm= Number of Multiple authors

Ns=Number of Single authors

Based on this study, the result of the degree of collaboration $C = 0.91$. i.e, 0.91% of collaborative authors' articles published during the study periods. Individual contribution is 83.54% in the field of space neuroscience research output. Multi author's contribution is 16.46% of the space neuroscience research output. The study interpreted that multi author contributed papers maintained the low profile among space neuroscience research scientists.

TABLE I SHOWS AUTHORSHIP PATTERN OF DEGREE OF COLLABORATION

Sl. No	Authorship pattern	Contribution	Cum.	%
1	Single Authors	127	127	8.32
2	Multi Authors	1398	1525	91.68
Total		1525		100.00
Degrees of collaboration				0.91

Table II shows the number of authors and their corresponding publications. Lotka’s Law, an inverse, square law, is used to find authors productivity patterns. It states that globally 83.54% of articles were from single authors, followed by 14% authors by double authors etc. 16.46% of multi-authored were globally contributes in this field of space neuroscience There is general decrease in performance among a body of authors following 1:n2. This ratio shows that some produce much more than the average. According to Lotka’s law of scientific productivity, only two percent of the authors in a field will produce more than 12 articles. The general form of Lotka’s law can be expressed as: $y = c/xn$.

The results depict that majority of papers are single authored. It clearly brings out collaborative research in the field It clearly brings out multi investigation is high compare than individual research in the field of space neuroscience.

The most productive author is Rabinovich MI and Spence C with each 6 papers dealing with space neuroscience and each 1.2% TLCS 8, TGCS 57, TLCS 7 and TLCS 8, TGCS 206 , TLCS 3 of all papers published in this research field. The authors of the seminal publication on space neuroscience given Table III Afraimovich VS (0.8%), TLCS 7, TGCS 50, TLCS 5 and Le Bihan D (0.8%), TLCS 0, TGCS 418, TLCS 0, appear on rank 2, respectively. It can be clearly visualized from the below table.

TABLE II AUTHORSHIP PATTERN

Sl. No	Authorship pattern	Recs.	Cum.	%
1	Single Authors	127	127	8.327869
2	Double Authors	210	337	13.77049
3	Three Authors	270	607	17.70492
4	Four Authors	244	851	16.00
5	Five Authors	200	1051	13.11475
6	Six Authors	108	1159	7.081967
7	Seven Authors	112	1271	7.344262
8	Eight Authors	96	1367	6.295082
9	Nine Authors	36	1403	2.360656
10	Ten Authors	30	1433	1.967213
	More than 10 authors	92	1525	6.032787
Total		1525		100

TABLE III AUTHOR’S WISE DOCUMENT DISTRIBUTION (FIRST -20 DOCUMENTS)

Sl. No	Author	Records	Percent	TLCS	TLCS/t	TLCSx	TGCS	TGCS/t	TLCSb	TLCSb	TLCSb
1	Rabinovich MI	6	1.2	8	1.50	2	57	12.22	7	0	0
2	Spence C	6	1.2	8	0.94	6	206	28.03	3	0	2
3	Afraimovich VS	4	0.8	7	1.00	1	50	10.22	5	0	2
4	Le Bihan D	4	0.8	0	0.00	0	418	41.66	0	0	0
5	Arecchi FT	3	0.6	0	0.00	0	28	3.13	0	0	0
6	Blanke O	3	0.6	0	0.00	0	3	1.17	2	0	0
7	Fekete T	3	0.6	3	0.83	0	3	0.83	4	0	0
8	Iriki A	3	0.6	3	0.25	3	85	7.58	0	1	0
9	Maguire EA	3	0.6	2	0.42	1	80	16.82	2	1	0
10	Paninski L	3	0.6	1	0.33	0	4	1.33	3	0	0
11	Timmer J	3	0.6	0	0.00	0	13	1.50	0	0	0
12	Toga AW	3	0.6	0	0.00	0	67	10.36	2	0	0
13	Aguirre GK	2	0.4	1	0.07	1	215	15.36	0	0	0
14	Akalal DBG	2	0.4	1	0.14	0	84	14.86	1	0	0
15	Amunts K	2	0.4	3	0.38	1	710	89.86	2	3	0
16	Bromberg PM	2	0.4	2	0.20	2	19	2.40	0	0	0
17	Brown EN	2	0.4	3	0.33	3	113	12.56	0	0	1
18	Brugger P	2	0.4	1	0.25	0	4	1.00	1	0	0
19	Buxbaum LJ	2	0.4	0	0.00	0	11	2.21	0	0	0
20	Calvert GA	2	0.4	4	0.44	3	147	16.33	0	0	2

The most productive Journal is Neuroimage with 21 papers dealing with space neuroscience and 4.3%, TCLS 11, TGCS 1137, TLCR 8 of all papers published in this research field. The journal of the seminal publication on

space neuroscience given table IV, Neuroscience Research and Neuropsychologia, appear on rank 2 (4.1.7%), TCLS 4, TGCS 235, TLCR 1 and 3 (2.5%), TCLS 2, TGCS 330, TLCR 3 respectively.

TABLE IV JOURNAL WISE DOCUMENT DISTRIBUTION (FIRST -20 DOCUMENTS)

Sl. No.	Journal	Records	Percent	TCLS	TLCS/t	TGCS	TGCS/t	TLCR
1	Neuroimage	21	4.3	11	1.84	1137	154.94	8
2	Neuroscience Research	20	4.1	4	0.35	235	24.64	1
3	Neuropsychologia	12	2.5	2	0.20	330	37.96	3
4	Journal of Neuroscience Methods	10	2.1	0	0.00	59	8.26	0
5	Journal of Physiology-Paris	10	2.1	0	0.00	187	20.83	1
6	Vision Research	10	2.1	2	0.20	218	26.21	1
7	Neuroscience	9	1.9	2	0.42	118	15.11	1
8	Journal of Cognitive Neuroscience	8	1.6	2	0.34	344	39.38	3
9	Current Biology	7	1.4	4	0.55	115	18.95	1
10	Journal of Computational Neuroscience	7	1.4	5	1.33	74	11.08	3
11	Journal of Neuroscience	7	1.4	2	0.22	139	22.86	3
12	Neural Networks	7	1.4	1	0.17	152	16.97	1
13	Plos One	6	1.2	0	0.00	13	4.25	2
14	Consciousness and Cognition	5	1.0	0	0.00	33	3.79	4
15	Journal of Neurophysiology	5	1.0	0	0.00	19	3.48	0
16	Neuroscience and Biobehavioral Reviews	5	1.0	0	0.00	24	7.75	0
17	Philosophical Transactions of the Royal Society B-Biological Sciences	5	1.0	3	0.70	87	17.85	3
18	Behavioral and Brain Sciences	4	0.8	0	0.00	216	20.07	0
19	Biological Cybernetics	4	0.8	0	0.00	25	5.43	2
20	Biosystems	4	0.8	1	0.17	25	4.67	2

The high frequency keywords will enable us to understand the various aspects of space neuroscience under study. The high frequency keywords were: Brain 12.1% (TCLS 7, TGCS 1278), Neuroscience 11.5% (TCLS 9,

TGCS 469), Space 10.9 % (TCLS 18, TGCS 701), Neural 6.6 % (TCLS 8, TGCS 613) and Analysis 5.6 % (TCLS 3, TGCS 566). Analysis of the keywords appeared either on the title or assigned by the indexer or the author himself will help in knowing in which direction the knowledge grows.

TABLE V WORD WISE DISTRIBUTIONS OF DOCUMENTS (FIRST -20 DOCUMENTS)

Sl. No.	Word	Records	Percent	TLCS	TGCS
1	Brain	59	12.1	7	1278
2	Neuroscience	56	11.5	9	469
3	Space	53	10.9	18	701
4	Neural	32	6.6	8	613
5	Analysis	27	5.6	3	566
6	Based	24	4.9	0	331
7	Cognitive	23	4.7	6	196
8	Human	22	4.5	6	683
9	Spatial	21	4.3	4	320
10	Model	19	3.9	0	141
11	Using	19	3.9	2	255
12	Neurons	18	3.7	4	435
13	Time	18	3.7	5	308
14	Memory	17	3.5	2	263
15	Functional	16	3.3	5	1428
16	Visual	16	3.3	2	187
17	Data	15	3.1	5	695
18	Imaging	15	3.1	5	824
19	Activity	14	2.9	10	230
20	Field	14	2.9	0	46

During 1999 - 2012, a total of 486 publications were published in space neuroscience by global. The average Number of Publications produced per year was 34.7%. The highest number of publications 70 was produced in 2010

Table VI was given year wise growth and collaboration rate in space neuroscience. It can be clearly visualized from the table that growth of the literature was very low during 1999. It Indicate that research in space neuroscience received a major impetus this period.

TABLE VI YEAR WISE DISTRIBUTION OF DOCUMENTS

Sl. No.	Publication Year	Records	Percent	TLCS	TGCS
1	1999	11	2.3	2	305
2	2000	16	3.3	1	282
3	2001	20	4.1	3	428
4	2002	20	4.1	7	720
5	2003	24	4.9	13	1485
6	2004	27	5.6	15	589
7	2005	33	6.8	8	1500
8	2006	30	6.2	3	614
9	2007	37	7.6	7	756
10	2008	48	9.9	10	693
11	2009	56	11.5	8	356
12	2010	70	14.4	7	384
13	2011	69	14.2	3	94
14	2012	25	5.1	0	6

Space neuroscience Scientists communicated their research results through a variety of communication channels. Table VI provides the distribution of publications in various channels of communication. It was observed that

72.6 % of the literature was published in Article followed by 13.4 % in Review, 8.8 % in Proceedings Paper, 3.9 % in Editorial Material, 0.6 % in Book Review, 0.4 % in Review; Book Chapter and 0.2 % in Biographical-Item.

TABLE VII SOURCE WISE DISTRIBUTION OF DOCUMENTS

Sl. No	Document Type	Records	Percent	TLCS	TGCS
1	Article	353	72.6	70	4875
2	Review	65	13.4	10	2503
3	Proceedings Paper	43	8.8	6	518
4	Editorial Material	19	3.9	1	192
5	Book Review	3	0.6	0	0
6	Review; Book Chapter	2	0.4	0	124
7	Biographical-Item	1	0.2	0	0

Table VIII Space neuroscience have contributed more predominantly in English than any other languages as 471 (96.9%) publications were in English followed by French 7

(1.4%), Spanish 3 (0.6%) German 2 (0.4%), Russian 2 (0.4) and Dutch 1(0.2%) publications.

TABLE VIII LANGUAGE WISE DISTRIBUTION DOCUMENTS

Sl. No.	Language	Records	Percent	TLCS	TGCS
1	English	471	96.9	87	8197
2	French	7	1.4	0	12
3	Spanish	3	0.6	0	3
4	German	2	0.4	0	0
5	Russian	2	0.4	0	0
6	Dutch	1	0.2	0	0

There were 567 institutions involved in research activity in the field of space neuroscience. Table, IX provides publication productivity of top 20 institutions. UCL topped

the list with 17 publications (3.5 %, TLCS 12, TGCS 1060) followed by University California San Diego with 14 publications (2.9 %, TLCS 11, TGCS 133), respectively.

TABLE IX INSTITUTION WISE DISTRIBUTION DOCUMENTS (FIRST -20 DOCUMENTS)

Sl. No.	Institution	Records	Percent	TLCS	TGCS
1	UCL	17	3.5	12	1060
2	University California San Diego	14	2.9	11	133
3	University Oxford	14	2.9	8	370
4	Harvard University	10	2.1	4	206
5	NYU	10	2.1	4	285
6	MIT	9	1.9	10	358
7	University California Los Angeles	9	1.9	0	280
8	Unknown	9	1.9	1	7
9	Washington University	8	1.6	6	359
10	Columbia University	7	1.4	1	54
11	University Penn	7	1.4	0	115
12	Princeton University	6	1.2	1	66
13	RIKEN	6	1.2	0	35
14	University California Davis	6	1.2	0	351
15	University Cambridge	6	1.2	1	60
16	University Freiburg	6	1.2	0	18
17	Cornell University	5	1.0	0	47
18	University Florence	5	1.0	0	33
19	University Florida	5	1.0	0	41
20	University Michigan	5	1.0	1	45

There were as many as 49 countries carrying out research in the field of space neuroscience. Table provides a list of collaboration countries whose research output is more than 50 publications. USA is top producing country with 194

publications (39.9%, TLCS 48, TGCS 3901) followed by UK with 71 publications (14.6%, TLCS 19, TGCS 1817), Germany with 39 Publications (8.0%, TLCS 7, TGCS 1397), respectively.

TABLE X COUNTRY WISE DOCUMENTS DISTRIBUTION (FIRST -20 COUNTRIES)

Sl. No.	Country	Records	%	TLCS	TGCS
1	USA	194	39.9	48	3901
2	UK	71	14.6	19	1817
3	Germany	39	8.0	7	1397
4	Japan	36	7.4	6	396
5	France	34	7.0	1	877
6	Italy	28	5.8	7	262
7	Unknown	22	4.5	1	144
8	Canada	20	4.1	1	277
9	Netherlands	15	3.1	4	132
10	Switzerland	15	3.1	1	62
11	Australia	14	2.9	1	166
12	Israel	10	2.1	3	150
13	Spain	10	2.1	1	176
14	Peoples R China	9	1.9	0	39
15	Sweden	9	1.9	1	82
16	Belgium	7	1.4	1	125
17	Mexico	6	1.2	8	51
18	India	5	1.0	0	82
19	Poland	5	1.0	1	11
20	Finland	4	0.8	1	359
21	Russia	4	0.8	0	6
22	South Korea	4	0.8	0	14
23	Denmark	3	0.6	0	20
24	Iran	3	0.6	0	4
25	Norway	3	0.6	0	16

26	Singapore	3	0.6	0	6
27	Austria	2	0.4	0	0
28	Greece	2	0.4	0	15
29	Ireland	2	0.4	1	22
30	South Africa	2	0.4	0	21
31	Taiwan	2	0.4	0	2
32	Uruguay	2	0.4	0	30
33	Brazil	1	0.2	0	3
34	Chile	1	0.2	0	2
35	Cyprus	1	0.2	0	9
36	Czech Republic	1	0.2	0	7
37	Estonia	1	0.2	0	17
38	Hungary	1	0.2	0	2
39	Lithuania	1	0.2	0	3
40	Malaysia	1	0.2	1	1
41	New Zealand	1	0.2	0	0
42	Philippines	1	0.2	0	1
43	Portugal	1	0.2	1	13
44	Rep of Georgia	1	0.2	0	0
45	Romania	1	0.2	0	0
46	Saudi Arabia	1	0.2	0	0
47	Serbia	1	0.2	0	0
48	Turkey	1	0.2	0	5
49	U Arab Emirates	1	0.2	0	0

The most cited reference is Talairach J., 1988, Coplanar Stereotaxic with 21 papers dealing with space neuroscience and each 4.3 % of all papers published in this research field. The cited reference of the seminal publication on space neuroscience given Table XI, appear on rank 2 & 3 O’Keefe J., 1978, Hippocampus Cognitiv and Felleman DJ, 1991, Cereb Cortex, V1, P1, DOI 10.1093/cercor/1.1.1 respectively. It can be clearly visualized from the below table.

X. CONCLUSION

The Growth rate of Space neuroscience literature is determined by calculating relative growth rates is declining trend. The most productive journal is “Neuroimage” and. According to Lotka’s law of scientific productivity, only two percent of the authors in a field will produce more than 12 articles. The general form of Lotka’s law can be expressed as: $y = c/x^n$. In Global level the above study shows the result of the degree of collaboration $C = 0.91$. i.e, 91% of collaborative authors’ articles published during the study periods. The most productive author is “Rabinovich MP”. The highest literature growth occurs in 2010 and highest Citation score in 2003 and 2005.

TABLE XI CITED REFERENCE WISE DOCUMENTS DISTRIBUTION (FIRST -20 COUNTRIES)

Sl. No.	Author / Year / Journal	Records	Percent
1	Talairach J., 1988, COPLANAR STEREOTAXIC	21	4.3
2	O'Keefe J., 1978, HIPPOCAMPUS COGNITIV	16	3.3
3	Felleman DJ, 1991, CEREB CORTEX, V1, P1, DOI 10.1093/cercor/1.1.1	13	2.7
4	Gibson J. J., 1979, ECOLOGICAL APPROACH	13	2.7
5	HODGKIN AL, 1952, J PHYSIOL-LONDON, V117, P500	13	2.7
6	Berti A, 2000, J COGNITIVE NEUROSCI, V12, P415, DOI 10.1162/089892900562237	12	2.5
7	Iriki A, 1996, NEUROREPORT, V7, P2325	12	2.5
8	Kanwisher N, 1997, J NEUROSCI, V17, P4302	12	2.5
9	OLDFIELD RC, 1971, NEUROPSYCHOLOGIA, V9, P97, DOI 10.1016/0028-3932(71)90067-4	12	2.5
10	Dayan P., 2001, THEORETICAL NEUROSCI	10	2.1
11	Haxby JV, 2001, SCIENCE, V293, P2425, DOI 10.1126/science.1063736	10	2.1
12	Maravita A, 2004, TRENDS COGN SCI, V8, P79, DOI 10.1016/j.tics.2003.12.008	10	2.1
13	OKEEFE J, 1971, BRAIN RES, V34, P171, DOI 10.1016/0006-8993(71)90358-1	10	2.1
14	Epstein R, 1998, NATURE, V392, P598, DOI 10.1038/33402	9	1.9
15	Farne A, 2000, NEUROREPORT, V11, P1645, DOI 10.1097/00001756-200006050-00010	9	1.9
16	Kandel ER, 2000, PRINCIPLES NEURAL SC	9	1.9
17	Marr D, 1982, VISION	9	1.9
18	Milner A. D., 1995, VISUAL BRAIN ACTION	9	1.9
19	Colby CL, 1999, ANNU REV NEUROSCI, V22, P319, DOI 10.1146/annurev.neuro.22.1.319	8	1.6
20	Damasio AR, 1999, FEELING WHAT HAPPENS	8	1.6

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