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AN EXAMINATION OF BRADFORD LAW: IDENTIFICATION OF CORE JOURNALS IN THE FIELD OF NEUROSCIENCE LITERATURE:

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ABSTRACT

In the present study an attempt has been made to explore and explain the research trend and productivity in the field of Neuroscience. The study is basically aims to analyse and test the applicability of Bradford's law and identification of core journals in the given field. For the present study, the research output is collected from Web of Science core Collection databases. In the present study there are 5776 journals covered 37976 articles which have received 110123 citations during the study period. The rank list of journals have been prepared with 5776 journals, it is found that "Neuroscience Research" journal is the most productive journals in the field of Neuroscience (2219-5.85%) and then followed by Elife (1241-3.27) and Journal of Neuroscience Methods with 836 articles. Further it is found that research articles are the major channels of communication for publication of research output and most of the publications are published in English language only. Finally, it can be concluded that Neuroscience literature does not follows Bradford Law of scattering for a given data set and however it is one the emerging subject in the field of Medical science.

Keywords: Bradford's law of Scattering, Bibliometrics, Neuroscience

1. Introduction:

Bibliometrics is potential area of research in the field of library and information science (LIS) pragmatic applications in measuring the growth and development of literature. It helps in formulating need-based collection building policy and provides authentic data to inform managers to take judicious decision in the process of document selection. Bibliometrics is also having wide range of applications the other field. Many research field use bibliometric methods to explore the impact of their field, the impact of the researchers, institutions and impact of the paper also. The term Bibliometrics was coined by Alan Pritchard in a paper published in 1969 entitled "statistical Bibliography or Bibliometrics". He defined the term as "the applications of mathematics and statistical methods to books and other media of communication.

An early example of a Bibliometric study was Statistical Analysis of the History of Science was conducted by Hulme and another study was the work of Gross and Gross in 1927 in which they counted and analyzed the citations in articles from the journal of the American Chemical society and produced a list of journals deemed important to chemical education. Another prominent work was Bradford's 1934 article on the distribution of literature in Lubrication research. It is an important part of the theoretical foundation of bilbiometrics "Bradford's Law of Scattering.

2. Literature Review

Many researchers in different subject areas have carried out bibliometric studies. These studies have covered many areas and have used different methodologies. A large number of Bibliometrics studies in different disciplines are conducted in foreign countries and some worthy full studies also reported from India. Applications of Bradford's law were examined by researchers using citations journals and dissertations of different subjects. Sudhier applied Bradford's law to the physics literature used by Indian Institute 1of Science for their doctoral theses. He found the law fit for the data set. Seminally Bentappanavar, Biradar & Kannappanavar applied

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Bradford's law of scattering to the journals of Botany cited by the doctoral students of Kuvempu University of India in 2their theses . He identified the pattern of journals use of the researchers to be perfect with Bradford's law of scattering. Neelamma & Anandhalli have studied the **Neelamma G and Gavisiddappa Anandhalli (2015)** the study reveals the various aspects of crystallography literature. such as year wise distribution, relative growth rate, doubling time, geographical wise, organization wise, Language wise, form wise, most prolific authors and funding agency etc. The highest numbers of articles were published in the year of 2011, while lowest numbers of research articles were reported in the year 1999. Further, the relative growth rate is gradually increaseing and on the other hand doubling time decreases. Most of the research publications are published in English language and in the form of research articles, China is the highest contributor to the field of Crystallography. In the article published by **Hadagali and Anandhalli (2015)** the study reveals that the growth of literature in neurology does not follow the linear or logistic model. However, it follows closely the exponential growth model; the study concludes that there has been a consistent trend towards increased growth of literature in the field of neurology.

3. Objectives of the study.

The main purpose of this study to accomplish the following objectives:

- Identification of the core journals in the field of Neuroscience.
- To test the applicability of Bradford's in the field of Neuroscience.
- To test the appropriateness of verbal and graphical formulation of Bradford's Law of scattering.

4. **Methodology.**

The data for the present study was collected from the Web of Science database of Thomson Reuters, UK. The research output covered in the Web of Science core Collection databases has been searched with the keyword as 'Neuroscience in the 'Title' for the period 1947-2018. It is found that the 5775 journals have published 37967 articles and these 5775 journals have been analyzed to test the Bradford law. the data so collected is analysed with help of MS excel spreadsheet to achieve the objectives of the study. The data analysis and interpretation is given in the following section.

5. Data Analysis and Interpretation

Table-1 Distributions of Publications according to type of Documents

Sl no	Type of Documents	No of articles	%	Cum %
1	Article	23050	60.70	60.70
2	Review	5225	13.76	74.45
3	Proceedings Paper	3871	10.19	84.65
4	Editorial Material	3336	8.78	93.43
5	Book Review	766	2.02	95.45
6	Meeting Abstract	747	1.97	97.42
7	Book Chapter	376	0.99	98.41
8	News Item	329	0.87	99.27
9	Letter	158	0.42	99.69
10	Correction	84	0.22	99.91
11	Biographical Item	17	0.04	99.96
12	Reprint	7	0.02	99.97
13	Data Paper	4	0.01	99.98
14	Retracted Publication	3	0.01	99.99
15	Bibliography	1	0.00	99.99
16	Early Access	1	0.00	100.00
17	Poetry	1	0.00	100.00
	Total	38327	100.00	

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The research output is published and communicated through various channels like, Article, Review, Proceedings Paper, Editorial Material, Book Review, Meeting Abstract, News Item, letters etc. it is observed from the table-1 that large majority of the publications are published in the form of articles (23050-60.14%), which is one the major mode of channel for communicating research output and then followed by Reviews (5225-13.76%), which constitute nearly 14% to the total publications. The Neuroscience literature also published in other forms like Proceedings Paper(3871-10.19%), Editorial Material(3376-8.78%), Book Review(766- 2.02%), Meeting Abstract(747- 1.97%), News Item(329- 0.89%), letters (158-0.42%) respectively. The research output is also published negligibly in other forms like Reprint, Data Paper, Retracted Publication and Bibliography. From the above analysis it can be revealed that research articles are the major form of channel used to communicate and publication of research output.

Table-2 Language wise Distribution of Articles

Sl no	Language	No of Records	%	Cum %
1	English	36812	96.93	96.93
2	Spanish	452	1.19	98.13
3	German	343	0.90	99.03
4	Italian	84	0.22	99.25
5	Portuguese	75	0.20	99.45
6	Russian	69	0.18	99.63
7	Chinese	34	0.09	99.72
8	Turkish	18	0.05	99.77
9	Hungarian	17	0.04	99.81
10	Czech	14	0.04	99.85
11	Polish	13	0.03	99.88
12	Croatian	7	0.02	99.90
13	Slovak	7	0.02	99.92
14	Slovenian	7	0.02	99.94
15	Japanese	6	0.02	99.95
16	Dutch	5	0.01	99.97
17	Estonian	3	0.01	99.97
18	Norwegian	3	0.01	99.98
19	Serbian	2	0.01	99.99
20	Catalan	1	0.00	99.99
21	Lithuanian	1	0.00	99.99
22	Romanian	1	0.00	99.99
23	Ukrainian	1	0.00	100.00
24	Welsh	1	0.00	100.00
	Total	38327	100.00	

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The table- 2 reveals language wise distribution of publications in the field of Neuroscience literature. It is observed from the above table that greater majority of the publication are being published in English language (36812-96.93%). It is because of English is being international language more over majority of the publications in the field of Medicine is being published in English language only. Further publications are also being published in other language like Spanish(452-1.19%) German (343-.90%), Spanish Italian (84-.22%), Portuguese (75-.20%), Russian (69-.18%) and Chinese (34-.09%) respectively.

6. Bradford's Law of Scattering

Samuel Clement Bradford, a chemist and chief librarian at the Landon Science Museum, has made a statistical analysis of two geophysics bibliographies, the Current Bibliography of Applied Geophysics (1992-1931) and the Quarterly Bibliography of Lubrication (1931-1933).

Bradford Law of scattering is used as a tool to study the output of journals. It expresses the quantitative connection between journals where the journals are arranged in descending order of productivity and divided into equal zones. He defined the first zone as "nuclear zone", which is highly productive and a small number of core journals belong to this zone. The second zone is moderately productive, while the third zone is less productive. Where the number of periodical in the nucleus and succeeding zones will be 1: n: n2, where n is a multiplier (Bradford, 1948). The observation of Bradford later described as linear relation by Brookes (Brookes, 1969) which is expressed as:

$$F(x)=a+b\log x$$

Where, F(x) is the cumulative number of reference contained in the first x most productivity journals, and a and b are constant.

Again, Vikery (Vickery, 1948) extended the verbal formulation of the Bradford law to show that its application in any number of zones of equal values. Later on Leimkuhler (Leimkuhler, 1967) has given a simple expression of Bradford law that is later known by his name and it is expressed as:

$$R(r)=a\log(1+br)$$

Where, R(r) is the cumulative number of articles contributed by journals ranked 1 through r, and a and b are parameters.

Similarly, Brookes derivation of journals productivity takes the form $R(r) = a \log (b/r)$

Further, Wilkinson (Wilkinson, 1972) noticed that the formulae provided by Leimkuhler and Brookes did not described the same phenomenon. Several other mathematicians provided different models but the Brookes and Bradford laws, however, gained more acceptance than others.

6.1 Theoretical Interpretation of Bradford's law

Bradford's law of scattering described a quantitative relationship between journals and the papers they publish. It explains that only small number of journals will needed to supply the nucleus of papers on given topic which accounts for a substantial percentage (1/3) of the articles, to be followed by a second larger group of journals that accounts for one third, while a much larger group of journals picked up the last third. There are two most widely recognized formulations of the Bradford's law : the verbal formulation which is derived from the verbal statement of Bradford's conclusion, and the graphical formulation which is an empirical expression derived from the graphical survey of a distribution of periodicals.

Bradford did not give a mathematical model for his law. Models were suggested later by Brookes, Vickery and Leimkuhler. Several authors, while explaining the scattering of articles in journals, have formulated many different models of Bradford's law. Leimuhler developed a model based on Bradford's verbal formulation.

$$R(r)= a \log (1+br) \quad (1)$$

$$r = 1,2,3\ldots\ldots$$

While explaining Leimukhler's law, Egghe shows that

$$a = Y_0 / \log k \quad (2)$$

$$b = k - 1 / r_0 \quad (3)$$

Here r_0 -is the number of sources in the first Bradford group

Y_0 – the number of items in every Bradford group (all these group of item being of equal sizes), and

k – the Bradford multiplier

R(r) is the cumulative number of items produced by the sources of rank 1,2,3…r

a and b are constants appearing in the law of Leimkuhler.

In forming Bradford groups, it is shown that the number of groups p is a parameter that can be chosen freely. Egghe (1990) has shown the mathematical formula for calculating the Bradford Multiplier k as

$$k= (e^y * Y_m)^{1/p} \quad (4)$$

Where is Euler's number (e^y=1.781)

If the sources are ranked in decreasing order of productivity, then Y_m is the number of items in the most productivity sources.

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Then y_0 and r_0 as follows

$$Y_0 = y^2_m \log k \quad (5) \quad \text{and}$$

$$R_0 = (k-1)\ Y_m \quad (6)$$

Once p is chosen, the value of k can be calculated by using

$$k = (1.781\ Y_m)^{1/p}$$

and $Y_0 = A/p \quad (7)$

where A denotes the total number of articles.

Let T denote the total number of journals in Bradford group, there are $r_0\ k^{i-1}$ sources (i= 1,2,3...p).

Table-3 Rank list of Journals in the field of Neuroscience

Sl no	Journal	Recs	%	Cum	No of citations	Cum citation	%
1	Neuroscience Research	2219	5.85	5.85	44471	44471	3.75
2	Elife	1241	3.27	9.12	12816	57287	1.08
3	Journal of Neuroscience Methods	836	2.21	11.33	27151	84438	2.29
4	Jove-Journal of visualized Experiments	695	1.84	13.17	3342	87780	0.29
5	Neuro image	584	1.54	14.71	36346	124126	3.06
6	Science	514	1.36	16.07	42430	166556	3.57
7	Plos One	439	1.16	17.23	8712	175268	0.74
8	Nature	438	1.16	18.39	17710	192978	1.49
9	Frontiers in Human Neuroscience	429	1.13	19.52	6513	199491	0.55
10	Journal Of Neuroscience	362	0.96	20.48	23868	223359	2.01
11	Frontiers in Psychology	322	0.85	21.33	3276	226635	0.28
12	Neuroscience	288	0.76	22.09	13834	240469	1.17
13	Neuron	284	0.75	22.84	23774	264243	2
14	Neuroscience and Biobehavioral Reviews	261	0.69	23.53	17317	281560	1.46
15	Proceedings of the National Academy of Sciences of the United States of America	255	0.68	24.21	19348	300908	1.63
16	Neuropsychologia	244	0.65	24.86	10921	311829	0.92
17	Journal of Cognitive Neuroscience	232	0.62	25.48	12684	324513	1.07
18	Trends in Cognitive Sciences	221	0.59	26.07	26368	350881	2.22
19	Current Opinion in Neurobiology	203	0.54	26.61	11455	362336	0.97
20	Nature Reviews Neuroscience	202	0.54	27.15	41290	403626	3.48
21	Journal of Neurophysiology	194	0.52	27.67	8283	411909	0.7
22	Journal of Neuropsychiatry and Clinical Neurosciences	187	0.5	28.17	3506	415415	0.3
23	Frontiers in Neuroscience	176	0.47	28.64	2338	417753	0.2

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24	Philosophical Transactions of the Royal Society b-Biological Sciences	173	0.46	29.1	9535	427288	0.81
25	Trends in Neurosciences	170	0.45	29.55	14503	441791	1.22
26	Scientific Reports	169	0.45	30	1436	443227	0.13
27	Nature Neuroscience	167	0.44	30.44	17981	461208	1.52
28	Brain Research	164	0.44	30.88	7175	468383	0.61
29	Current Biology	163	0.43	31.31	4564	472947	0.39
30	The Journal of Neuroscience Nursing : Journal of the American Association of Neuroscience Nurses	156	0.42	31.73	743	473690	0.07
31	Journal of the History of the Neurosciences	148	0.39	32.12	819	474509	0.07
32	Social Cognitive and Affective Neuroscience	147	0.39	32.51	4964	479473	0.42
33	Brain Research Bulletin	134	0.36	32.87	2183	481656	0.19
34	Human Brain Mapping	134	0.36	33.23	5557	487213	0.47
35	Cortex	125	0.33	33.56	2768	489981	0.24
36	Consciousness and Cognition	124	0.33	33.89	3508	493489	0.3
37	Biological Psychiatry	122	0.33	34.22	7628	501117	0.65
38	Frontiers in Neuro Informatics	120	0.32	34.54	2096	503213	0.18
11	Behavioural Brain research	118	0.32	34.86	4260	507473	0.36
12	Neuro Informatics	117	0.31	35.17	2556	510029	0.22
13	Experimental Brain Research	114	0.31	35.48	5678	515707	0.48
14	Behavioral and Brain Sciences	113	0.3	35.78	8042	523749	0.68
15	Cerebral Cortex	107	0.29	36.07	6499	530248	0.55
16	European Journal of Neuroscience	107	0.29	36.36	2956	533204	0.25
17	Science (Newyork, n.y.)	104	0.28	36.64	12661	545865	1.07
18	Neuroscience letters	103	0.28	36.92	4459	550324	0.38
19	Psychological Science	102	0.27	37.19	5094	555418	0.43
20	Journal of Undergraduate Neuroscience Education : June : a Publication of Fun, Faculty for Undergraduate Neuroscience	101	0.27	37.46	286	555704	0.03
21	Journal of Neuroscience Research	99	0.27	37.73	2103	557807	0.18
22	Brain and Cognition	97	0.26	37.99	3922	561729	0.33
23	ACS Chemical Neuroscience	93	0.25	38.24	1030	562759	0.09

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24	Neural Networks	93	0.25	38.49	3116	565875	0.27
25	Revista De Neurologia	92	0.25	38.74	585	566460	0.05
26	Journal of Neuroscience Nursing	89	0.24	38.98	419	566879	0.04
27	Plos Computational Biology	88	0.24	39.22	2416	569295	0.21
28	Schizophrenia Bulletin	88	0.24	39.46	4316	573611	0.37
29	Vision Research	87	0.23	39.69	4035	577646	0.34
30	Frontiers in Computational Neuroscience	86	0.23	39.92	812	578458	0.07
31	Current Directions in Psychological Science	85	0.23	40.15	4890	583348	0.42
32	International Journal of Psychophysiology	83	0.22	40.37	2077	585425	0.18
33	Social Neuroscience	83	0.22	40.59	1964	587389	0.17
34	Neurology	82	0.22	40.81	6662	594051	0.57
35	Neuroscientist	79	0.21	41.02	3701	597752	0.32
36	Journal of Computational Neuroscience	77	0.21	41.23	3141	600893	0.27
37	Brain	75	0.2	41.43	6018	606911	0.51
38	Neurocomputing	75	0.2	41.63	613	607524	0.06
39	Neurosurgery	75	0.2	41.83	1378	608902	0.12
40	Neurosciences	74	0.2	42.03	356	609258	0.03
41	Frontiers in Behavioral Neuroscience	73	0.2	42.23	1000	610258	0.09
42	Neuroethics	73	0.2	42.43	553	610811	0.05
43	Neurosciences and Music III: Disorders and Plasticity	73	0.2	42.63	2212	613023	0.19
44	Journal of Consciousness Studies	72	0.19	42.82	811	613834	0.07
45	Neuroreport	71	0.19	43.01	3607	617441	0.31
46	Methods in Molecular Biology (clifton, n.j.)	70	0.19	43.2	664	618105	0.06
47	Canadian Journal of Neurological Sciences	68	0.18	43.38	882	618987	0.08
48	Frontiers in Systems Neuroscience	68	0.18	43.56	2158	621145	0.19
49	American Journal of Bioethics	67	0.18	43.74	755	621900	0.07
50	Brain Research Reviews	66	0.18	43.92	6277	628177	0.53
51	Cognitive Affective & Behavioral Neuroscience	65	0.18	44.1	1564	629741	0.14
52	Neural Computation	65	0.18	44.28	1497	631238	0.13
53	Mind Brain and Education	64	0.17	44.45	883	632121	0.08
54	Physics of Life Reviews	64	0.17	44.62	673	632794	0.06

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55	Developmental Cognitive Neuroscience	63	0.17	44.79	1270	634064	0.11
56	Progress in Neurobiology	63	0.17	44.96	5257	639321	0.45
57	American Journal of Psychiatry	61	0.17	45.13	4190	643511	0.36
58	Visual Neuroscience	61	0.17	45.3	2045	645556	0.18
59	Psychophysiology	59	0.16	45.46	2973	648529	0.26
60	Synthese	59	0.16	45.62	704	649233	0.06
61	Archives of Neurology	58	0.16	45.78	2661	651894	0.23
62	Journal of Neural Engineering	57	0.16	45.94	1257	653151	0.11
63	Emotion Review	56	0.15	46.09	1057	654208	0.09
64	Neurobiology of Learning and Memory	56	0.15	46.24	1599	655807	0.14
65	Biological Cybernetics	55	0.15	46.39	1945	657752	0.17
66	Current Topics in Behavioral Neurosciences	55	0.15	46.54	798	658550	0.07
67	Physical Review e	55	0.15	46.69	1380	659930	0.12
68	Journal of Physiology-Paris	54	0.15	46.84	1250	661180	0.11
69	philosophical Psychology	54	0.15	46.99	401	661581	0.04
70	Psychological Bulletin	54	0.15	47.14	9902	671483	0.84
71	psychonomic Bulletin & Review	54	0.15	47.29	2518	674001	0.22
72	Wiley Interdisciplinary Reviews-Cognitive Science	54	0.15	47.44	913	674914	0.08
73	Neurosciences and Music	53	0.14	47.58	1669	676583	0.15
74	Perspectives on Psychological Science	53	0.14	47.72	3488	680071	0.3
75	Year In Cognitive Neuroscience	53	0.14	47.86	3169	683240	0.27
76	Brain and Language	52	0.14	48	1729	684969	0.15
77	Cognition	52	0.14	48.14	4594	689563	0.39
78	Frontiers in Neuroanatomy	51	0.14	48.28	609	690172	0.06
79	Journal of Neurosurgery	51	0.14	48.42	1413	691585	0.12
80	Zygon	51	0.14	48.56	230	691815	0.02
81	Biological Psychology	48	0.13	48.69	2835	694650	0.24
82	Hearing Research	48	0.13	48.82	1315	695965	0.12
83	Neurocritical Care	48	0.13	48.95	768	696733	0.07
84	Neuropsycho Pharmacology	47	0.13	49.08	2199	698932	0.19
85	Reviews in the Neurosciences	47	0.13	49.21	1797	700729	0.16

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86	Journal of Comparative Neurology	46	0.13	49.34	1274	702003	0.11
87	The journal of Comparative Neurology	46	0.13	49.47	4160	706163	0.35
88	Critical Care Medicine	45	0.12	49.59	2759	708922	0.24
89	IEEE Transactions on Biomedical Engineering	45	0.12	49.71	1118	710040	0.1
90	Neurosciences and Music iv: Learning and Memory	45	0.12	49.83	895	710935	0.08
91	Academic Psychiatry	44	0.12	49.95	323	711258	0.03
92	Development and Psychopathology	44	0.12	50.07	3560	714818	0.3
93	Experimental Neurology	44	0.12	50.19	1029	715847	0.09
94	Current Opinion in Behavioral Sciences	43	0.12	50.31	313	716160	0.03
95	Schizophrenia Research	43	0.12	50.43	1510	717670	0.13
96	Current Opinion in Neurology	42	0.12	50.55	1634	719304	0.14
97	Journal of Clinical Neuroscience	42	0.12	50.67	209	719513	0.02
98	Medical Hypotheses	42	0.12	50.79	427	719940	0.04
99	Developmental Science	41	0.11	50.9	2492	722432	0.21
100	Frontiers in Neural Circuits	41	0.11	51.01	552	722984	0.05
101	Hippocampus	41	0.11	51.12	1666	724650	0.15
102	Neuroquantology	41	0.11	51.23	159	724809	0.02
103	Dialogues in Clinical Neuroscience	40	0.11	51.34	1049	725858	0.09
104	International Journal of Psychoanal ysis	39	0.11	51.45	627	726485	0.06
105	Neurology India	39	0.11	51.56	205	726690	0.02
106	Physiology & Behavior	39	0.11	51.67	2109	728799	0.18
107	Plos Biology	39	0.11	51.78	1428	730227	0.13
108	World Neurosurgery	39	0.11	51.89	268	730495	0.03
109	Behavior Research Methods	38	0.11	52	391	730886	0.04
110	Frontiers in Aging Neuroscience	38	0.11	52.11	285	731171	0.03
111	Journal of Integrative Neuroscience	38	0.11	52.22	429	731600	0.04
112	Annual Review of Psychology	37	0.1	52.32	12219	743819	1.03
113	Autonomic Neuroscience-Basic & Clinical	37	0.1	52.42	307	744126	0.03
114	Molecular Psychiatry	37	0.1	52.52	2979	747105	0.26
115	Psychological Medicine	37	0.1	52.62	1525	748630	0.13

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116	Frontiers in Cellular Neuroscience	36	0.1	52.72	556	749186	0.05
117	Frontiers in Psychiatry	36	0.1	52.82	479	749665	0.05
118	Journal of Child Psychology and Psychiatry	36	0.1	52.92	1892	751557	0.16
119	Journal of the American Psychoanalytic Association	36	0.1	53.02	952	752509	0.09
120	American Psychologist	35	0.1	53.12	2348	754857	0.2
121	Journal of vestibular Research-Equilibrium & Orientation	35	0.1	53.22	485	755342	0.05
122	Methods	35	0.1	53.32	919	756261	0.08
123	Nature Methods	35	0.1	53.42	2867	759128	0.25
124	Oncotarget	35	0.1	53.52	89	759217	0.01
125	Perception	35	0.1	53.62	527	759744	0.05
126	Prion Diseases of Humans and Animals	35	0.1	53.72	301	760045	0.03
127	The Journal of Neuroscience : The Official Journal of the Society for Neuroscience	35	0.1	53.82	2567	762612	0.22
128	Annals of Neurology	34	0.09	53.91	2649	765261	0.23
129	Learning & Memory	34	0.09	54	2072	767333	0.18
130	Nature Communications	34	0.09	54.09	619	767952	0.06
131	Nervenarzt	34	0.09	54.18	143	768095	0.02
132	Neurosciences and Music v: Cognitive Stimulation and Rehabilitation	34	0.09	54.27	404	768499	0.04
133	Psychological Review	34	0.09	54.36	6535	775034	0.55
134	Biosocieties	33	0.09	54.45	395	775429	0.04
135	Science and Engineering Ethics	33	0.09	54.54	130	775559	0.02
136	Brain Structure & Function	32	0.09	54.63	768	776327	0.07
137	CNS Spectrums	32	0.09	54.72	555	776882	0.05
138	Cognitive Neuroscience	32	0.09	54.81	429	777311	0.04
139	Current Opinion in Psychiatry	32	0.09	54.9	514	777825	0.05
140	Frontiers of Neurology and Neuroscience	32	0.09	54.99	194	778019	0.02
141	Journal of Affective Disorders	32	0.09	55.08	584	778603	0.05
142	Neuropharmacology	32	0.09	55.17	759	779362	0.07
143	The American Journal of Psychiatry	32	0.09	55.26	613	779975	0.06
144	Theory & Psychology	32	0.09	55.35	376	780351	0.04

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145	Aviation, Space, and Environmental medicine	31	0.09	55.44	781	781132	0.07
146	British Journal of Neurosurgery	31	0.09	55.53	306	781438	0.03
147	Computational Neuroscience: Theoretical Insights into Brain Function	31	0.09	55.62	1095	782533	0.1
148	Journal of Biological Chemistry	31	0.09	55.71	788	783321	0.07
149	Journal of Biomedical Optics	31	0.09	55.8	1311	784632	0.12
150	Neurotherapy: Progress in Restorative Neuroscience and Neurology	31	0.09	55.89	1364	785996	0.12
151	Philosophy of Science	31	0.09	55.98	597	786593	0.06
152	Progress in Neuro-Psychopharmacology & Biological Psychiatry	31	0.09	56.07	942	787535	0.08
153	Psychopathology	31	0.09	56.16	318	787853	0.03
154	BMC Neuroscience	30	0.08	56.24	1013	788866	0.09
155	Clinical Neurophysiology	30	0.08	56.32	2758	791624	0.24
156	Journal of Clinical Investigation	30	0.08	56.4	291	791915	0.03
157	Proceedings of the Royal Society b-Biological sciences	30	0.08	56.48	1472	793387	0.13
158	Stroke	30	0.08	56.56	1647	795034	0.14
159	Axone (Dartmouth, n.s.)	29	0.08	56.64	95	795129	0.01
160	Handbook of Clinical Neurology	29	0.08	56.72	89	795218	0.01
161	Journal of Neurology Neurosurgery and Psychiatry	29	0.08	56.8	712	795930	0.06
162	Neural Regeneration Research	29	0.08	56.88	94	796024	0.01
163	Review of General Psychology	29	0.08	56.96	384	796408	0.04
164	Behavioral Neuroscience	28	0.08	57.04	458	796866	0.04
165	Biosystems	28	0.08	57.12	234	797100	0.02
166	Current Protocols in neuroscience	28	0.08	57.2	301	797401	0.03
167	Emotion	28	0.08	57.28	1572	798973	0.14
168	Journal of Analytical Psychology	28	0.08	57.36	168	799141	0.02
169	Lab on a Chip	28	0.08	57.44	835	799976	0.08
170	Neurobiology of Aging	28	0.08	57.52	796	800772	0.07
171	Topics in Cognitive Science	28	0.08	57.6	828	801600	0.07
172	Frontiers in Integrative Neuroscience	27	0.08	57.68	242	801842	0.03
173	Heliyon	27	0.08	57.76	52	801894	0.01

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174	IEEE Transactions on Neural Systems and Rehabilitation Engineering	27	0.08	57.84	358	802252	0.04
175	Lancet neurology	27	0.08	57.92	1842	804094	0.16
176	Psychoanalytic Psychology	27	0.08	58	283	804377	0.03
177	Psychopharmacology	27	0.08	58.08	1443	805820	0.13
178	Advances in Physiology Education	26	0.07	58.15	379	806199	0.04
179	Annual Review of Neuroscience, vol 35	26	0.07	58.22	4753	810952	0.4
180	Child Development Perspectives	26	0.07	58.29	756	811708	0.07
181	Journal of Neurology	26	0.07	58.36	279	811987	0.03
182	Journal of Vision	26	0.07	58.43	360	812347	0.04
183	Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences	26	0.07	58.5	317	812664	0.03
184	Psychiatry Research	26	0.07	58.57	805	813469	0.07
185	sensing and controlling motion: vestibular and sensorimotor function	26	0.07	58.64	446	813915	0.04
186	Annals of the Newyork Academy of Sciences	25	0.07	58.71	52	813967	0.01
187	Annual Review of Neuroscience, Vol 40	25	0.07	58.78	205	814172	0.02
188	Behavioural Processes	25	0.07	58.85	502	814674	0.05
189	Brain Imaging and Behavior	25	0.07	58.92	443	815117	0.04
190	Cell	25	0.07	58.99	866	815983	0.08
191	Epilepsy & Behavior	25	0.07	59.06	512	816495	0.05
192	International Journal of Developmental Neuroscience	25	0.07	59.13	684	817179	0.06
193	Journal of Experimental Psychology-General	25	0.07	59.2	994	818173	0.09
194	Language Cognition and Neuroscience	25	0.07	59.27	179	818352	0.02
195	Psychiatry Research-Neuroimaging	25	0.07	59.34	614	818966	0.06
196	Scientometrics	25	0.07	59.41	355	819321	0.03
197	The European Journal of Neuroscience	25	0.07	59.48	1528	820849	0.13
198	Annual Review of Neuroscience, Vol 34	24	0.07	59.55	4887	825736	0.42
199	Annual Review of Neuroscience, Vol 36	24	0.07	59.62	1869	827605	0.16
200	Annual Review of Neuroscience, vol 37	24	0.07	59.69	1659	829264	0.14
201	Biology & Philosophy	24	0.07	59.76	359	829623	0.04

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202	British Journal of Psychiatry	24	0.07	59.83	808	830431	0.07
203	Cambridge Quarterly of Healthcare Ethics	24	0.07	59.9	81	830512	0.01
204	Journal of Neurochemistry	24	0.07	59.97	733	831245	0.07
205	Neuropsychology Review	24	0.07	60.04	1023	832268	0.09
206	Proceedings of the IEEE	24	0.07	60.11	1063	833331	0.09
207	ACTA Astronautica	23	0.07	60.18	211	833542	0.02
208	Aphasiology	23	0.07	60.25	340	833882	0.03
209	Brain and Nerve = Shinkei Kenkyu No Shinpo	23	0.07	60.32	70	833952	0.01
210	Computational Intelligence and Neuroscience	23	0.07	60.39	2628	836580	0.23
211	Journal of Neurosurgical Anesthesiology	23	0.07	60.46	329	836909	0.03
212	American Journal of Clinical Hypnosis	22	0.06	60.52	128	837037	0.02
213	Annual Review of Neuroscience	22	0.06	60.58	11899	848936	1.01
214	developmental Psychobiology	22	0.06	60.64	774	849710	0.07
215	Frontiers in Molecular Neuroscience	22	0.06	60.7	551	850261	0.05
216	Jama Psychiatry	22	0.06	60.76	623	850884	0.06
217	Journal of Neural Transmission	22	0.06	60.82	468	851352	0.04
218	Journal of Statistical Mechanics-Theory and Experiment	22	0.06	60.88	202	851554	0.02
219	Phenomenology and the Cognitive Sciences	22	0.06	60.94	254	851808	0.03
220	spinal Cord	22	0.06	61	649	852457	0.06
221	Archives of General Psychiatry	21	0.06	61.06	2643	855100	0.23
222	Brain Research Protocols	21	0.06	61.12	276	855376	0.03
223	Brain Topography	21	0.06	61.18	1145	856521	0.1
224	Epilepsia	21	0.06	61.24	603	857124	0.06
225	Functional Neurology	21	0.06	61.3	188	857312	0.02
226	International Journal of Developmental Neuroscience : the Official Journal of the International Society for Developmental Neuroscience	21	0.06	61.36	433	857745	0.04
227	Journal of Visualized Experiments : Jove	21	0.06	61.42	232	857977	0.02
228	Neuropsychology	21	0.06	61.48	409	858386	0.04
229	Psychological Inquiry	21	0.06	61.54	380	858766	0.04
230	Revue Neurologique	21	0.06	61.6	102	858868	0.01

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231	19 Journals contains 20 articles	380	1.01	62.61	13263	872131	1.12
232	19 Journals contains 19 articles	399	1.06	63.67	12509	884640	1.06
233	19 Journals contains 18 articles	342	0.91	64.58	9659	894299	0.82
234	20 Journals contains 17articles	340	0.9	65.48	11308	905607	0.96
235	30 Journals contains 16 articles	480	1.27	66.75	11397	917004	0.96
236	24 Journals contains 15articles	360	0.95	67.7	6664	923668	0.57
237	21 Journals contains 14 articles	294	0.78	68.48	8819	932487	0.75
238	41 Journals contains 13 articles	533	1.41	69.89	16973	949460	1.43
239	48Journals contains 12 articles	576	1.52	71.41	19971	969431	1.68
240	41 Journals contains 11 articles	451	1.19	72.6	12157	981588	1.03
241	51 Journals contains 10 articles	510	1.35	73.95	9986	991574	0.84
242	69 Journals contains 9 articles	621	1.64	75.59	17014	1008588	1.44
243	62 Journals contains 8 articles	496	1.31	76.9	9576	1018164	0.81
244	102 Journals contains 7 articles	714	1.89	78.79	19664	1037828	1.66
245	97 Journals contains 6 articles	582	1.54	80.33	12682	1050510	1.07
246	164Journals contains 5 articles	820	2.16	82.49	20760	1071270	1.75
247	245 Journals contains 4 articles	980	2.59	85.08	21422	1092692	1.81
248	447 Journals contains 3 articles	1341	3.54	88.62	27029	1119721	2.28
249	867 Journals contains 2 articles	1734	4.57	93.19	28342	1148063	2.39
250	3133 Journals contains 1 articles	3133	8.25	100	40841	1188904	3.44
	Total	**37976**	**100**		**1188904**		**100**

The ranked list of most cited journals of Neuroscience Literature is shown in the Table 3. In the analysis, the articles are distributed in 5776 journals with a total of 37976 articles. From the Table 3 it is clear that "Neuroscience Research" journal is the most productive journals in the field of Neuroscience (2219-5.85%) occupies the first position in the neuroscience subject and then followed by Elife (1241-3.27) which is in the second position and Journal of Neuroscience Methods with 836 articles occupies third position in the list. The total number of articles (37976) are distributed in 5776 journals, in which, more than fifty percent of the articles are covered in 92 journals, which can be considered as most productive journals in the field of Neuroscience.

Bradford Zones of scattering of journals

Zone	Journal	% of Journal	Articles	% of Articles	Calculated values
I	34	0.59	12682	33.4	22
II	374	6.48	12803	33.72	346
III	5367	92.94	12491	32.9	5405
	5775	100	37976	100	

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In the present data set, 34 journals covered 12682 articles, next 374 journals covered 12803 articles and next 5367 journals covered 12491 articles. In other words, one third of the total articles have been covered by each group of the journals. According to Bradford, the zones, thus identified will form an approximately geometric series in the form 1: n: n^2 . But it is found that the relationship of each zone in the present study is 34: 374: 5367. This does not fit into the Bradford's distribution. Here, first zone represent the number of periodicals (34) in the nucleus.

7. Application of Leimkuhler Model.

For testing of the Bradford law, the 5775 journals are divided into three zones, since Bradford assumes that there should be minimum three zones i.e p=3 then the value of K can be calculated by using the formula

$$k= (e^{y} *Y_m)^{1/p}$$

$$k= (1.781*2219)^{1/3} =15.6$$

$$Y_0=A/p= 37976/3= 12458.67$$

$$r_0= \frac{T(K-1)}{K^p-1} =22.1$$

$$r_1= r_0 *k=346.47$$

$$r_2 = r_0 *k^2= 5405$$

$$a=\frac{Y0}{LogK} = \frac{12458.67}{\log(15.6)} =10442.05$$

$$b=K - \frac{1}{r_0} = 15.556$$

From the table -1 it is observed that the number of journals in the nucleus zone is found to be 34 and k=15.6 is a multiplier. Therefore, the Bradford distribution is

$$34: 34*15.6 : 34*15.6^2 \approx 1:n:n^2 \;\; 34: 530.4: 3796.416 = 4360.816$$

$$\text{Percentage of error} = \frac{4360.8160-5775}{5775} X100 = -24.488\%$$

Hence, it can be observed from the above calculation that the percentage of error is very large (24.488%) and Bradford's Law of scattering does not fit in the present given data for Neuroscience literature for given multiplier k=15.6. therefore, it can be noticed that the theoretical distribution is different from the observed distribution for a given data set. Hence, it can be concluded that Bradford's law of scattering does not fit/ followed in the field of Neuroscience literature.

8. Graphical Formulation

The graphical approach was developed by Brookes, which is verify the verbal formulation of Bradford's law (Brooks 1969). The graph is plotted as shown in the figure-1 Log of Cumulative Number of Journals is taken on X axis and Cumulative number of articles is taken on Y axis. The nature of the curve shows that the distribution is exhibit three characteristics rapid raise for little initial number of articles later the curve is gradually linear moment in the middle and at the tail end there is rapid exponential raise.

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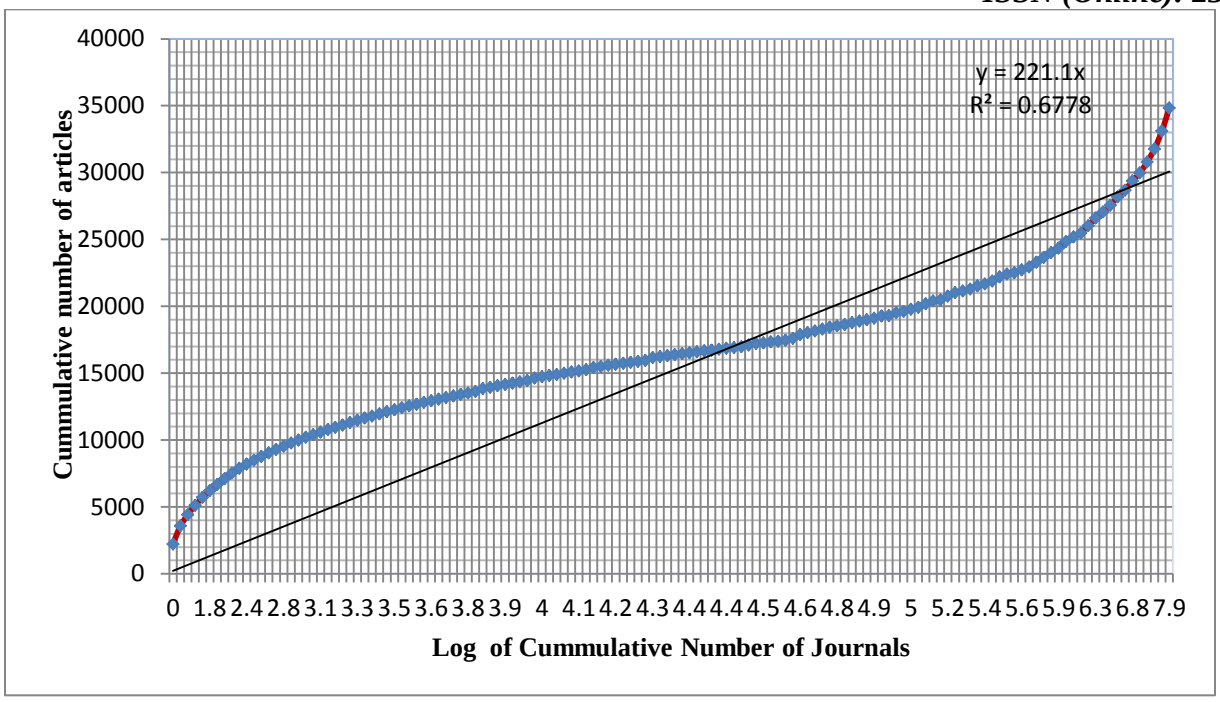

9. Conclusion:

Through this study it is found that there were 37976 articles published during the study period from 2000 to 2018 which, which covers the different subfield of neuroscience and these articles have been published by more than 5776 journals. As per the theoretical aspects of the Branford Law one third of journals as per Bradford zone should have published maximum number of articles. There is difference between observed values (34:374:5367) and the calculated value (22:346: 5405) in each zone. Furthermore, high percentage of error is also observed (24%) for the given data set. Hence, the Bradford's law of scattering does not fit for the given dataset. However, it has a greater importance for identification of core journals in a given field. It is found that "Neuroscience Research" journal is the most productive journals in the field of Neuroscience and then followed by Elife and Journal of Neuroscience Methods. Further it is found that research articles are the major channels of communication for publication of research output and most of the publications are published in English language only. Finally, it can be concluded that Neuroscience is one of the emerging subject in the field of Medical science.

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