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Indian Doctoral Researches in Neuroscience: A Scientometric Study

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Abstract **- Neuroscience is a mix up of research outputs emanated from various disciplines like medicine, biotechnology, biochemistry, psychology, pharmacology, computer science, linguistics etc. Even experts in management also started thinking about the underlying neurological facts behind successful decision making in business and Management. This paper explains the contribution of universities towards Indian neuroscience in the form of theses. Here we can see the interdisciplinary contribution to the field. The source of data was "Shodhganga" maintained by Information and Library Network (INFLIBNET) Centre. The initiatives of different states, universities and guides are given detailed. The subjects in which active research is going on in Indian universities are identified. The findings of the study are useful for those who keenly examine India's productivity on neuroscience.**
Keywords: **Shodhganga, Neuroscience, States, Universities, Guides, Subjects, Departments**

I. INTRODUCTION

Most often research starts from a question or an assumption from the insight of the researcher based on some problems being manifested while going deep into the related subject literature. What we see today all around us, every facility which makes us comfortable is the results of yesterday's research. Research is an inevitable process in the direction of advancement of any discipline. If it is either in basic or applied science, the subject gets dynamic changes due to the invention of new theories or technologies. As decades pass, trends in science research are also undergoing some visible changes.

The meaning of neuroscience as stated in Oxford dictionary (Concise Oxford English Dictionary, 2011) is "Any or all of the sciences concerned with nervous system and brain." At the same time in some dictionaries the term "neuroscience" is not seen and they use "neurology" to represent the field of study. In medical dictionary (New Concise Medical Dictionary, 2006) the term neurology is given as "The branch of medical science which deals with the nervous system both normal and in disease."Just as how neuroscience studies are important in the field of medicine, the other branches of medicine themselves are also important and connected in several ways to the field of neuroscience. The studies in genetics, molecular biology, biochemistry, pharmacology, psychology, oncology, physiology, anatomy etc are also associated with neuroscience in many aspects. Computer science, electronics and speech language pathology have their own contribution in neuroscience and associated areas to bring into light the most complex nerve cell structure, features, functions, symptoms and diseases using sophisticated technologies. Even the areas like yoga and philosophy have some indirect relation with neurosciences.

II. REVIEW OF LITERATURE

Man started thinking about brain and its functions from the commencement of his memory (Chopra, R. N. *et al.*, 1958). Even now the curiosity to explore brain and creating the same in an artificial way is on the way to its extremity in many countries. Studies reported that there is a 76.68% of growth rate in Indian medical research in between 2004-08 compared to the results of the period 1999-03 and the organ-wise break-up of publications revealed that brain and heart are the areas in which extensive research is being conducted followed by artery, vein and lungs. In medicine, a study covering the period from 1998 to 2008 clearly stated that India is on the 12th position among the most productive countries in medical literature in the world, and has 65,745 papers to its credit. (Gupta, and Bala, 2011). While searching for the previous studies in the same area, it was found that the doctoral works in which quantitative studies in neuroscience were conducted, were less in number. A study on retrograde Amnesia in neuroscience shows how effectively researchers from various disciplines like biotechnology, psychiatry, biophysics, biochemistry, linguistics, pharmacology work together for a single objective. (Schwechheimer and Winterhager, 2001) The article (Butler and Senior, 2007) emphasised the importance of Organisational Cognitive Neuroscience (OCN), in which they also experiment with all fields of business and management to get a picture on human behaviour in organisations and above all to trace out the social behaviour. Satija describes the beginning, development and education in library and Information Science in India along with the trends and areas of research by analysing doctoral research works submitted in different Indian universities (Satija, 1998).

Research output comes in many forms. Theses brought out from universities or research and development organisations as part of PhD programmes have vital role in the dissemination of new horizons of knowledge in the respective subject area. This article examines the extent to which India has contributed Theses in neuroscience and its allied branches as covered by Shodhganga, the repository of Indian theses maintained by INFLIBNET Centre, Gujarat.

III. OBJECTIVES OF THE STUDY

The main objectives of the study are

1. To examine the contribution of Indian universities towards neuroscience in the form of theses
2. To analyse the state-wise contribution
3. To identify the leading universities according to productivity
4. To determine the most vibrant research supervisors in Indian universities
5. To find out the allied subjects which are often gives new knowledge to neuroscience

IV. SCOPE OF THE STUDY

Shodhganga, the online open access repository of Indian theses by INFLIBNET covers 2,06,713 (as on 26th October 2018) (Shodhganga,2018) full text records in different subjects from the universities all over India with an objective to centralise, preserve and share with the academic community world-wide. Out of which the theses which dealt with many aspects of neuroscience and related areas like neuropsychology, biochemistry, pharmacy, pharmacology, biotechnology, and medical entomology and toxicology were consulted. The study focuses to trace out the role of Indian theses in neuroscience and related areas of research, most productive Indian universities, states & UTs which are rich with institutions doing dynamic research, areas of active study and guides who supervised more theses related to the field.

V. LIMITATION OF THE STUDY

The universities approved by University Grants Commission (UGC) are categorised as state universities (298), central universities (44), deemed universities (130) and private universities (148).Most of the notable universities in India (406 universities) have signed MoU(UGC, 2018) with UGC for sharing their knowledge assets in the form of theses. Around 355 universities including top ranking in India have contributing to Shodhganaga. Even though some universities are there yet to make an agreement with UGC and not made available their documents in Shodhganga. More than 65% of notable Indian universities have added their works to the repository and the rest of them (35%) are really not much productive in the higher education sector in India. This study does not cover the above said research works which are not shared with INFLIBNET.

VI. METHODOLOGY

The theses repository, Shodhganaga is created and maintained on the DSpace, free software which offers platform to create and get digital objects stored systematically. It supports search of contents in many ways. The study used the term “Neuroscience/neuroscience” in the subject search field and retrieved 2558 responses. From which some irrelevant results were omitted as they contain some terms like neuro, nerve and brain as part of narrating a novel or describing intelligence or thought somewhere in the work. After the filtration process 2280 papers were found suitable and started analyses using the same data.

VII. ANALYSIS AND INTERPRETATION OF DATA

The figures given below are self-explanatory about the total collection in Shodhganga, data taken for the study and excluded things too. The whole data collected from Shodhganga through search (2558), was not taken as such as some of them are not absolutely connected to neuroscience or not related with any of its branches.

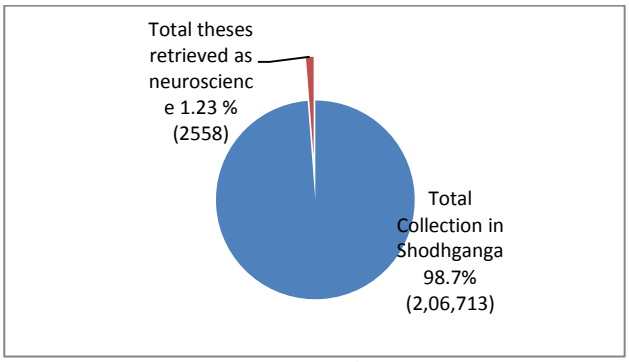

Fig. 1 Data representation from Shodhganga

The omitted data from the total search output is depicted here. The actual data accounts for only 1.23% of the entire collection.

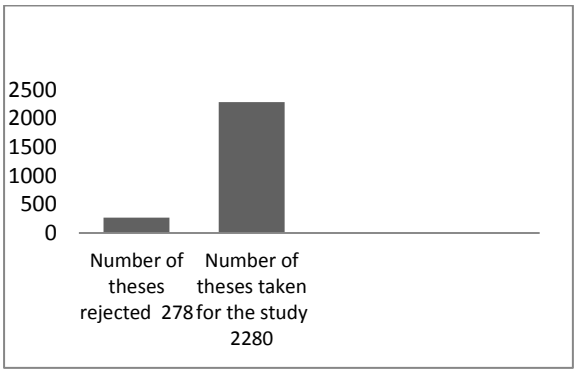

Fig. 2 Actual data and irrelevant data

Nearly 10.87% of the total retrieved was not suitable to be included in the study. The entire study and results were based on the 2280 theses.

A. State-Wise Study of Theses

In south India, Tamil Nadu is the first among the most contributing states with 324 theses and Punjab is identified as the top among north Indian states with 174 theses.

TABLE I STATE-WISE PRODUCTIVITY- SOUTHERN & NORTHERN INDIA

South Indian States with Number of Theses		Percentage (All over India)	North Indian States with Number of Theses		Percentage (All over India)
Tamil Nadu	324	14.21	Punjab	174	7.63
Karnataka	259	11.36	Uttar Pradesh	139	6.09
Andhra Pradesh	167	7.32	Haryana	45	1.97
Kerala	126	5.52	Himachal Pradesh	18	0.79
Telangana	94	4.12	Jammu & Kashmir	13	0.57
			Uttarakhand	6	0.26
Total	970	42.53	Total	395	17.31

While going through the theses to identify the vibrant Indian states which are highly productive in conducting studies connected to neuroscience and allied branches, Tamil Nadu was found to be the top most state all over India. The states Karnataka, West Bengal and Punjab were secured the next top positions to Tamil Nadu. The table I gives the details of the states and their productivity. Uttar Pradesh and Haryana are the next productive north Indian states with 139 and 45 theses respectively. The states Himachal Pradesh, Jammu Kashmir and Uttarakhand have less number of theses in neurosciences. The most encouraging fact is that all the states in both south and north India have given their contribution to Shodhganga.

TABLE II STATE-WISE PRODUCTIVITY- WESTERN, EASTERN & NORTH-EAST INDIA

West Indian States with Number of Theses		Percentage (All over India)	East Indian and North-East Indian States with Number of Theses		Percentage (All over India)
Maharashtra	143	6.27	West Bengal	232	10.17
Gujarat	116	5.08	Odisha	24	1.05
Rajasthan	104	4.56	Assam	25	1.09
Goa	8	0.35	Meghalaya	9	0.39
			Manipur	4	0.175
			Tripura	3	0.087
			Mizoram	2	0.131
			Sikkim	1	0.043
			Arunachal Pradesh	1	0.043
			Nagaland	1	0.043
			Jharkhand	----	
			Bihar	----	
Total	371	16.26	Total	302	13.22

At the same time, Maharashtra, Gujarat and Rajasthan were found to be the west-Indian states which give more research support to the field neuroscience. Goa was an exception in it with 8 theses only. The Eastern Indian states Bihar and Jharkhand have no role among the contributors to the theses reservoir. West Bengal as a state of east India had given 232 theses related to the subject of study. The north-east part of India is not blessed with numerous scientific and research institutions, top-ranking universities etc. At the same time all north-Indian states have their presence in neuroscience and allied areas research. Assam has good number of theses in comparison with Bihar and Jharkhand.

The two states Chhattisgarh and Madhya Pradesh in central India have 15 theses in neuroscience. As we know Indian union territories Delhi and Pondicherry (1) are also listed among the contributors. The results from Delhi (214) 9.34% is a challenge for the other top most productive states in India in terms of the number of research works coming out to shodhganga. When compared to others parts, the southern states of India is highly contributing with 970 theses.

TABLE III STATE-WISE PRODUCTIVITY-CENTRAL INDIAN STATES

Central Indian States with Number of Theses		Percentage (All over India)
Chhattisgarh	15	0.66
Madhya Pradesh	12	0.52
Total	27	1.18

B. University-Wise Study of Theses

The most productive universities identified from study are shown below.

TABLE IV UNIVERSITIES AND PRODUCTIVITY

Universities	No. of Theses	Percentage	State/UTs
University of Kolkata	176	7.72	West Bengal
Punjab University	145	6.36	Punjab
JNU	141	6.18	Delhi (UT)
Aligarh Muslim University	95	4.17	Utter Pradesh
Sri Venkateswara University	92	4.04	Karnataka
Manipal University	90	3.95	Karnataka
BITS	57	2.5	Goa
Jamia Hamdard University	56	2.5	Delhi (UTs)
University of Hyderabad	53	2.32	Telangana
University of Kerala	50	2.19	Kerala
Manonmaniam Sundaranar University	48	2.10	Tamil Nadu
Savithribai Phule Pune University	45	1.97	Maharashtra
Maharaja Sayajirao University, Baroda	45	1.97	Gujarat
Bharathiar University	39	1.71	Tamil Nadu
University of Madras	36	1.58	Tamil Nadu
University of Mysore	35	1.54	Karnataka
Jawaharlal Nehru Technological University, Ananthpur	31	1.36	Andhra Pradesh
Bharathidasan University	30	1.32	Tamil Nadu
MadhuraiKamaraj University	27	1.18	Tamil Nadu
Cochin University of Science and Technology (CUSAT)	27	1.18	Kerala
Total (2280)	1318	57.80	

The University of Kolkata has the highest score of 176 theses and this is the only one university among both East and North-East Indian States which seems most supporting for research in the field of neuroscience and related fields. Among the above top productive twenty states Karnataka and Tamil Nadu support research extensively and the universities in these states compete each other to establish their identity in higher education and research.

TABLE V TOP PRODUCTIVE RESEARCH GUIDES

Guides	Subject	No. of Papers	Universities
Paulose, CS	Biotechnology	17	CUSAT
Kulkarni, SK	Pharmaceutical science	17	Punjab Univ
Upmanyu, VV	Psychology	12	Punjab Univ
Islam, Fakhrul	Medical Elementology &Toxicology	11	Jamia Hamdard University
Mohan Jitendar	Psychology	11	Punjab Univ
Poddar, MK	Biochemistry	9	University of Calcutta
Yogeswari, P	Pharmaceutical science	9	Birla Institute of Technology and Science
Mukhopadhyay,Kanchan	Biotechnology	9	University of Calcutta
Suresh, B	Zoology	8	Maharaja Sayajirao University of Baroda
Reddanna,P	Animal sciences	8	University of Hyderabad
Koley,Juthika	Physiology	7	University of Calcutta
Malick, Birendra Nath	Life Sciences	7	JNU
Sandhir,Rajat	Biochemistry	7	Punjab University

Table V provides the list of nineteen top ranking guides who supervised considerably more number of theses in their respective fields connected to neuroscience. The works conducted without any supervisor were about 9. The study identified both Paulose, C S of Department of Biotechnology, Cochin University of Science and

Technology and Kulkarni, S K of Department of Pharmaceutical science, Punjab University as the highly productive guides with 17 theses in their credit. Upmanyu, V V, from Punjab university supervised 12 theses in his subject psychology. There are 11 theses supervised by Islam Fakhrul and Mohan Jitendar. The subject of the first guide is medical elementology and toxicology and the latter academician is a professor in psychology. Each guide in the list is the most sought after person in India in the concerned literature.

Poddar, M K supervised 9 theses on the subject biochemistry Yogeswari, P and Kanchan Mukhopadhyaya had the same number of theses in the fields Pharmaceutical science and biotechnology respectively. Suresh B, Guha, Debjani and Reddanna P are the experts in zoology, department of science and animal sciences respectively who guided 8 theses each. There are 7 theses to the credit of Koley, Juthika, Malick, Birendra Nath and Sandhir Rajat. It can be seen that guides from both punjab university and university of calcutta are very dynamic and sincere to their field and most of the works were from physiology, biochemistry, biotechnology, pharmaceutical sciences and psychology.

TABLE VI SUBJECT-WISE STUDY

Subject	No. of PhDs	Most Productive University	State
Zoology	309	Venkateswara University	Andhra Pradesh
Biotechnology	169	University of calcutta	Calcutta
Psychology	122	Punjab University	Punjab
Biochemistry	96	Punjab University	Punjab
Chemistry	90	University of Burdwan and Aligarh Muslim University	West Bengal and Uttar Pradesh
Physiology	58	University of Calcutta	West Bengal
Computer Science	51	Bharathiar University and Jain University	Tamil Nadu and Karnataka
Education	41	Annamalai univ, Alagappa univ and Maharshi Dayanad univ	Tamil Nadu and Haryana
Pharmacology	35	Gujarat University	Gujarat
Pharmacy	30	BITS	Rajasthan
Med.Elementology & Toxicology	29	Jamia Hamdard University	New Delhi
Animal Sciences	29	University of Hyderabad	Telangana
Physical Education	27	Alagappa University	Tamil Nadu

As discussed earlier different branches contributed to the subject neuroscience in different consistency. The department of zoology from different universities in India produced more theses in connection with neuroscience. It is 309 in number followed by department of biotechnology (169) and department of psychology (122). The other subjects which show near relation and affinity with neuroscience are biochemistry (96), chemistry (90) and physiology (58). The branch computer science has proved its connection and contribution to the field neuroscience. It has been observed that as going downwards in the list, the relation of subjects with neuroscience has became farther. Pharmacology and pharmacy are the other two branches of medicine, produced 35 and 30 theses respectively. The table VI covers only the top 14 departments which have more studies related to the field neuroscience in one or many aspects. The departments listed here are diverse in subjects. Out of the 57.3% of total research done by Venkateswara University, Andhra Pradesh was in zoology.

VIII. FINDINGS

There were 2,06,713 theses in Shodhganga, the Indian theses repository (as on 21st October 2018). Out of which 2558 theses retrieved under search on 'neuroscience' and excluded nearly 10.87% of theses as they were irrelevant to the topic and the rest of the 2250 theses were examined.

The major findings of the study are given below

1. The Indian universities contributed 2280(1.10%) theses to neuroscience and its associated branches.
2. The most productive Indian states and Union Territories in the subject neurosciences in Shodhganga are:

a. South Indian states: Tamil Nadu (14.21%), Karnataka (11.36%) and Andhra Pradesh (7.32%)
b. North Indian states: Punjab (7.63%), Utter Pradesh (6.09%) and Haryana (1.97%)
c. Western Indian states: Maharashtra (6.27%), Gujarat (5.08%) and Rajasthan (4.56%)
d. East Indian and North-East Indian states: West Bengal (10.17%), Odisha (1.05%) and Assam (1.09%)
e. Central Indian states: Chhattisgarh (0.66%) and Madhya Pradesh (0.52%)
f. As a Union Territory, Delhi (9.34%) has more publications and it stands on the third position if compare with other states in India.

g. Jharkhand and Bihar are the states which found to be null productive in the discipline

3. University of Kolkata (7.72%), Punjab University (6.36%) and Jawaharlal Nehru University (JNU) (6.18%, Delhi are the universities having the highest number of theses contribution in Shodhganga.
4. The guides who found to be the most productive in the major branches connected to neurosciences are given below:

a. Biotechnology: Paulose C S, Cochin University of Science and Technology (CUSAT), Kerala
b. Pharmaceutical Sciences: Kulkarni, S.K., Punjab University, Punjab
c. Psychology: Upmanyu V.V., Punjab University, Punjab
d. Medical Elementology and toxicology: Islam, Fakhrul, Jamia Hamdard University,
e. Biochemistry: Poddar, M. K., University of Calcutta
f. Zoology: Suresh B., (Maharaja Sayajirao University of Baroda)
g. Animal Sciences: Reddanna P., University of Hyderabad
h. Physiology: Koley, Juthika, University of Calcutta
i. Life Sciences: Malick, Birendra Nath, JNU

5. Taking the contribution of various subjects to neuroscience, zoology produced maximum and the most vibrant institute in the field is, Venkateswara University, Andhra Pradesh. The branch Biotechnology is the next most productive field and University of Calcutta is identified as the most productive university in the field. Psychology and Biochemistry were the next subjects contributed to the core field and Punjab University was most productive university in these two areas. Chemistry, Physiology followed by Computer science, Education, Pharmacology, Pharmacy, Medical elementology and toxicology, Animal sciences and Physical education are the other major subjects shared research to the field neuroscience.

IX. CONCLUSION

Each research work is an attempt to add new knowledge to the subject. The literature comes out in many forms according to the academic community, before whom it is presented. Theses are the intellectual properties of universities and are submitted as part of fulfilment of a PhD programme. Theses require years and years of cumulative experiences compared to compiling journal articles. At the time when many universities involve in this venture, a visible growth can be seen in Shodhganga in terms of the number of neuroscience theses. Shodhganga has a role as an input centre of Indian theses works to the world irrespective of discipline. The quality of the research work is shown by the advancement of research in universities in India in related branches of neuroscience and it also proves that these sub fields do unquestionable role in the development of the discipline.

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