Productivity and Impact of the Top 100 Cited Parkinson's Disease Investigators since 1985

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Abstract. We have compiled a list of the 100 most cited researchers in Parkinson's disease since 1985 together with H-Indices as a means to assess productivity and impact. Within the total-citations ranking, "broad impact" citations are used as a way of identifying those researchers whose work is cited widely beyond the Parkinson's disease research community. Finally, we present a table of the most cited researchers this decade for a comparison of the two with analysis.

Keywords: Parkinson's disease, neurodegenerative diseases, neurosciences, bibliometrics, scientometrics, H-index, authorship, factual databases, ranking, citation, citation analysis, highly-cited, history of science

INTRODUCTION

The number of citations an article receives is widely accepted as a measure of its impact. In recent years, the field of Parkinson's Disease (PD) research has been the focus of two bibliometric studies in which the mosthighly cited papers were identified [1] and a partial ranking of top authors was generated [2]. There has not, however, been a broad analysis of the PD research literature to assess, in a comprehensive manner, the impact and productivity of the top investigators, which this study aims to provide.

METHODS

The following three dimensions were selected as a basis to measure the work in PD by individual

investigators: total citations, "broad impact" citations and H-index. Briefly, the H-index is a measure of an author's highly cited body of work rather than of individual papers – for details see [3, 4]. Broad impact citations are a new measure, discussed below. The underlying data used in the tabulation of each dimension originate from Thomson Reuter's ISI Web of Science (WoS).

Two selection filters were used in determining which papers would contribute to an individual scientist's metrics. The first filter was a requirement that all papers to be included in the analysis mention "Parkinson," "Parkinson's," "Parkinsons," "Parkinsonism," or "Parkinsonian" in the title while excluding those papers which contained the term "amyotrophic" in the title field or alternatively "wolff-parkinson-white" in the title, abstract, or keyword fields. The above exclusion criteria were added when it became clear that, without them, a number of papers which are primarily about ALS and Wolff-Parkinson-White syndrome would lessen the accuracy of the analysis through the introduction of data points which are false-positive in nature. The second filter is temporal: only papers

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published and subsequently indexed in WoS between 1 January 1985 and 17 February 2011 were considered. We selected this time period because it is one which has seen remarkable progress and yet is still recent enough that almost all of the investigators in the rankings are still alive. It is important to recognize the effects of the temporal filter as researchers who made fundamental contributions to the field prior to 1985 but have since slowed in the areas of impact and productivity will be underrepresented in this study due to the 1985 limitation. Melvin Yahr and Margaret Hoehn, who, in a landmark paper in 1967, introduced what has long been the standard classification system of PD disease progression, are a case in point. Also of importance is the PD-specific filter, as some prominent PD scientists have strong interests in other areas. Their impact and productivity in non-PD fields will not be recognized in this analysis. John Trojanowski, of the University of Pennsylvania, and Maria Grazia Spillantini, of the University of Cambridge, are prime examples of this phenomenon as their research focuses on the mechanisms which underlie a wide range of neurodegenerative disorders.

Continuing along this line of thought, it seems that analyzing only papers with PD in the title may favor articles on translational or clinical studies for the reason that basic scientists studying the mechanisms underlying PD appear to be less apt to include PD in the titles of their papers. As an example, Spillantini and Trojanowski together with collaborators, Marie Luise Schmidt, Virginia M.-Y. Lee, Ross Jakes, and Michel Goedert, wrote a landmark paper published in Nature in 1997 which mentioned PD in the abstract, but not in the title [5]. Entitled, "alpha-synuclein in Lewy bodies", the paper has accumulated 1,945 citations to date which would have made it the third most-cited paper in the current analysis, had it been included. An analysis of the "false positive" papers which would have been included in the study by relaxing the requirement of a PD-specific title, however, led us to the decision to mandate that PD appear in the title in line with previous studies [1]. A first example of a highly-cited paper which might have been included through the employment of a more relaxed search strategy is "The Consortium to Establish a Registry for Alzheimer's Disease (CERAD). Part II. Standardization of the neuropathologic assessment of Alzheimer's disease" [6], which appeared in Neurology in 1991 and has accumulated 2,444 citations to date. This high-impact AD paper happened to contain PD in its keyword list and is, therefore, returned when one uses the default "Topic" search in WoS. A second example is "Cloning of the gene for a human dopamine D4 receptor with high affinity for the antipsychotic clozapine" [7], which appeared in *Nature* in 1991 and has accumulated 1,708 citations to date. PD is mentioned in the abstract of this paper, and while the dopamine-receptor research described in this paper may have had a sizeable indirect impact in the world of PD research, it is clear that a paper such as this has its "conceptual home" squarely within the world of schizophrenia investigation.

It is interesting to note that the clinical/translational bias observed in the current analysis appears, anecdotally, to be more apparent than that observed in a similar study conducted in the area of Alzheimer's Disease (AD) [8]. When compared to PD, the historic lack of clinical treatment options for people with AD might, in part, explain why the clinical/translational bias is more evident in the PD study. As demonstrated through the example of the alpha-synuclein paper above, another contributing factor could be the stricter requirement in the current study regarding the appearance of the disease in question in the title of the article.

Reviews were included in the analysis because, while it is relatively "easy" to write a review, it is very difficult to write a review that is well-cited. Well-cited reviews tend to be authored by leaders in the field and present conceptual advances or new hypotheses that can be as important as experimental advances.

While the underlying paper-level data were provided by WoS extracts, the author-specific tabulations of number of papers, "broad impact" citations (see below for further discussion), total citations, and Hindex were achieved through the use of the Thomson Reuters HistCite software package [9]. HistCite facilitates author-level bibliometric analysis within a given literature base.

Full names for the PD researchers in this study were derived from the publicly-available BiomedExperts [10] repository, which allows for the accurate extraction of full names (i.e., last name, first name, middle initial) through author-disambiguation algorithms. While powerful, it was clear during the analysis that the automated, author-disambiguation routines used in assigning papers to the individual scientists are not perfect, so manual checking was used in addition. The metrics, therefore, represent a good approximation of impact and productivity rather than an exact measurement.

BiomedExperts.com was also utilized in determining each scientist's main line of investigation. The top five MeSH terms from each investigator's research profile in BiomedExperts were considered. The highest-ranked MeSH term within the top five

Table 1

Most-cited authors from 1 January 1985 through 17 February 2011 based on citation counts for PD papers indexed in Thomson Reuters ISI WoS and aggregated in Thomson Reuters HistCite software package (institutional affiliation and total number of PD papers in WoS are also indicated)

Rank for	Investigator	Affiliation	Total	# of
Total	(* = Appeared in		citations	PD
Citations	JAD Top 100 analysis [8])			Papers
1	Lees, Andrew J	University College London	23,095	459
2	Marsden, C David	University College London	22,235	235
3	Agid, Yves	Pitié - Salpêtrière University Hospital	19,699	365
4	Lang, Anthony E	Toronto Western Research Institute	16,489	365
5	Olanow, C Warren	Mount Sinai School of Medicine	13,759	247
6	Brooks, David J	Imperial College London	12,052	259
7	Jenner, Peter	King's College London	12,045	160
8	Mizuno, Yoshikuni	Juntendo University School of Medicine	10,418	324
9	Fahn, Stanley	Columbia University	9,549	204
10	Benabid, Alim-Louis	Joseph Fourier University	9,316	154
11	Goetz, Christopher G	Rush University Medical Center	9,191	318
12	Quinn, Niall P	University College London	9,184	228
13	Pollak, Plerre	Joseph Fourier University	9,008	190
14	Hirsch, Ettenne C	Plue - Salpetriere University Hospital	8,891	1//
15	Koller, william C	University of North Carolina	8,855	255
10	Diadarar Datar*	Universität Würzburg	8,349	103
17	Innkovic Joseph	Baylor College of Medicine	8,242 8,023	318
10	Danial Sugar E	University College London	8,023 7 284	211
19	Tanner, Caroline M	The Parkinson's Institute	7,204	211
21	Farrer Matthew I	Mayo Clinic - Florida	7,204	237
21	Obeso Jose A	University of Navarra	7,241	201
22	Biörklund Anders	Lund University	7,175	90
23	Hattori Nobutaka	Juntendo University School of Medicine	6 864	228
25	Youdim Moussa B H	Technion - Israel Institute of Technology	6,667	133
26	Langston, J William	The Parkinson's Institute	6,661	149
27	Golbe, Lawrence I	University of Medicine and Dentistry of New Jersey	6.561	84
28	Schapira, Anthony H V	University College London	6,515	170
29	Przedborski, Serge	Columbia University	6,512	83
30	Calne, Donald B	University of British Columbia	6,393	156
31	Nutt, John G	Oregon Health & Science University	6,320	220
32	Rascol, Olivier	University of Toulouse	6,144	340
33	Wood, Nicholas W	University College London	6,021	144
34	Gasser, Thomas	University of Tübingen	5,926	160
35	Poewe, Werner	Innsbruck Medical University	5,892	326
36	Dexter, David T	Imperial College London	5,846	45
37	Jellinger, Kurt A*	University of Vienna	5,797	116
38	Nussbaum, Robert L	University of California San Francisco	5,770	32
39	Javoy-Agid, France	Pitié - Salpêtrière University Hospital	5,697	78
40	Chase, Thomas N	Hamilton Pharmaceuticals.	5,668	137
41	Maraganore, Demetrius M	Mayo Clinic - Minnesota	5,633	153
42	Bonifati, Vincenzo	Erasmus University	5,611	136
43	DeLong, Mahlon R	Emory University	5,394	73
44	Shoulson, Ira	University of Rochester	5,371	87
45	Oertel, Wolfgang H	The Philipps University	5,317	279
46	Stern, Matthew B	University of Pennsylvania	5,284	212
47	Duvoisin, Roger C	University of Medicine and Dentistry of New Jersey	5,193	54
48	Krack, Paul	Joseph Fourier University	5,143	101
49 50	Bonnet, Anne-Marie	Plue - Salpetriere University Hospital	5,131	110
50	Singleton, Andrew	Induonal Institute of Aging - NIH	5,108	11/
51	Larsen, Jan Petter	Stavanger University Hospital	5,053	1/0
52 52	nugnes, Andrew J Kieburtz, Korl	University of Netbourne	5,017	4/
55 54	Mayoux Dioherd*	Columbia University	3,010	92
55	Pothwall John C	University College London	4,919	105
55	Hardy John*	University College London	4,023 1 818	0J 121
57	Brice, Alexis	Pitié - Salpêtrière University Hospital	4,802	135

Rank for	Investigator	Affiliation	Total	# of
Total	(* = Appeared in		citations	PD
Citations	JAD Top Too analysis [8])			Papers
58	Limousin, Patricia	University College London	4,752	73
59	Brundin, Patrik	Lund University	4,731	65
60	Eidelberg, David	Feinstein Institute for Medical Research	4,683	203
61	Albanese, Alberto	Università Cattolica del Sacro Cuore	4,674	92
62	Pahwa, Rajesh	University of Kansas	4,636	193
63	LeWitt, Peter	Wayne State University	4,553	113
64	Polymeropoulos, Mihael H	Vanda Pharmaceuticals	4,531	20
65	Dawson, Ted M	Johns Hopkins University	4,518	77
66	Lindvall, Olle	Lund University	4,514	65
67	Robbins, Trevor W	University of Cambridge	4,510	48
68	Frackowiak, Richard S J	University College London	4,507	29
69	Aarsland, Dag	Stavanger University Hospital	4,476	167
70	Hauser, Robert A	University of South Florida	4,451	181
71	Rajput, Ali H	University of Saskatchewan	4,369	126
72	Pfeiffer, Ronald F	University of Tennessee	4,307	114
73	Wszolek, Zbigniew K	Mayo Clinic – Florida	4,232	179
74	Benazzouz, Abdelhamid	Université de Bordeaux	4,212	37
75	Kordower, Jeffrey	Rush University Medical Center	4,203	90
76	Marek, Kenneth	Institute for Neurodegenerative Disorders	4,176	136
77	Weiner, William J	University of Maryland - Baltimore	4,146	172
78	Rehncrona, Stig	Lund University	4,069	224
78	Tolosa, Eduardo	University of Barcelona	4,069	40
80	Hubble, Jean P	Novartis Pharmaceuticals Corporation	4,057	90
81	Watts, Ray L	University of Alabama at Birmingham	4,053	151
82	Trojanowski, John Q*	University of Pennsylvania	4,019	50
83	Jackson-Lewis, Vernice	Columbia University	3,995	48
84	Sawle, Guy V	Nottingham University	3,989	34
85	Müller, Thomas	St. Joseph Hospital Berlin-Weissensee	3,957	163
86	Widner, Håkan	Lund University	3,933	60
87	Stoessl, A Jon	University of British Columbia	3,917	109
88	Meco, Giuseppe	Sapienza University	3,905	96
89	Shults, Clifford W	University of California San Diego	3,827	64
90	Beal, M Flint*	Cornell University	3,776	61
91	Leenders, Klaus L	University Medical Center Groningen	3,771	108
92	Vila, Miquel	University Hospital Vall d'Hebron	3,754	43
93	Greenamyre, J Timothy	University of Pittsburgh	3,751	53
94	Johnson, William G	University of Medicine and Dentistry of New Jersey	3,686	13
95	Lazzarini, Alice M	University of Medicine and Dentistry of New Jersey	3,682	13
96	Friedman, Joseph H	Brown University	3.671	165
97	Dawson, Valina L	Johns Hopkins University	3.646	45
98	Gwinn-Hardy, Katrina	National Institute of Neurological Disorders and Stroke - NIH	3.629	77
99	Przuntek, Horst	Ruhr-University of Bochum	3.583	107
100	Lansbury, Peter T	Harvard University	3,557	28

Table 1 (continued)

for a given scientist that could be considered a PD line of investigation was chosen as the main line of investigation for the researcher in question. It is important to note that the papers used to generate the top five MeSH terms for each scientist were not restricted to those papers mentioning PD, but were taken from a collection of PubMed papers representative of an investigator's entire corpus of published work. It follows, then, that the line of investigation chosen for each researcher is not necessarily the line of investigation most frequently found within that scientist's PD papers. The MeSH term chosen is, however, one that the scientist has applied to their PD research and, more importantly, is the line of investigation most representative of the entire research portfolio of the investigator in question. This approach to line-of-investigation identification, while not always completely accurate, allows a broad picture of the areas of expertise of the most cited researchers within the world of PD research without attempting to compare competing MeSH-term frequencies within an investigator's PD-specific paper corpus. Authors with the most broad-impact citations using the same document base as Table 1 (institutional affiliation and total citations are also indicated)

Rank for Broad	Investigator	Affiliation	Broad impact	Total
impact citations			citations	citations
1	Marsden, C David	University College London	10,783	22,235
2	Agid, Yves	Pitié - Salpêtrière University Hospital	9,745	19,699
3	Lees, Andrew J	University College London	8,452	23,095
4	Jenner, Peter	King's College London	7,547	12,045
5	Olanow, C Warren	Mount Sinai School of Medicine	7,440	13,759
6	Lang, Anthony E	Toronto Western Research Institute	5,979	16,489
7	Hirsch, Etienne C	Pitié - Salpétrière University Hospital	5,473	8,891
8	Mizuno, Yoshikuni	Juntendo University School of Medicine	5,296	10,418
9	Brooks, David J	Imperial College London	5,161	12,052
10	Riederer, Peter	Universität wurzburg	5,012	8,242
11	Bonshid Alim Louis	Iocomb Fourier University	4,522	0,007
12	Belladid, Allin-Louis	Joseph Fourier University	4,234	9,510
15	Bjorklund, Anders Przedborski Serge	Columbia University	4,077	7,040
14	Pollak Pierre	University of Grenoble	3,880	9,008
15	Fahn Stanley	Columbia University	3,676	9 549
17	Lozano Andres M	University of Toronto	3,675	8 349
18	Koller William C	University of North Carolina	3 573	8 853
19	Quinn Niall P	University College London	3 536	9 184
20	Obeso, Jose A	University of Navarra	3,487	7,173
20	Schapira Anthony H V	University College London	3 443	6 515
21	Hattori Nobutaka	Juntendo University School of Medicine	3 405	6 864
23	Dexter David T	Imperial College London	3,386	5.846
23	Javov-Agid France	Pitié - Salpêtrière University Hospital	3,368	5,697
25	Iellinger Kurt A	University of Vienna	3,268	5 797
26	Singleton, Andrew	National Institute of Aging - NIH	3,222	5,108
20	Langston, I William	The Parkinson's Institute	3,180	6.661
28	Jankovic, Joseph	Baylor College of Medicine	3,134	8.023
29	Goetz, Christopher G	Rush University Medical Center	3.081	9,191
30	Nussbaum Robert L	University of California San Francisco	2.983	5,770
31	Calne. Donald B	University of British Columbia	2,776	6.393
32	Sawle, Guy V	Nottingham University	2,769	3,989
33	Beal. M Flint	Cornell University	2,757	3.776
34	Brundin. Patrik	Lund University	2,752	4.731
35	Trojanowski, John Q	University of Pennsylvania	2,725	4,019
36	Farrer, Matthew J	Mayo Clinic – Florida	2,689	7,241
37	Daniel. Susan E	University College London	2.674	7.284
38	Rajput, Ali H	University of Saskatchewan	2,658	4,369
39	Lansbury, Peter T	Harvard University	2,655	3,557
40	DeLong, Mahlon R	Emory University	2,649	5,394
41	Limousin, Patricia	University College London	2,630	4,752
42	Lee, Virginia M-Y	University of Pennsylvania	2,576	3,544
43	Dawson, Ted M	Johns Hopkins University	2,575	4,518
44	Golbe, Lawrence I	University of Medicine and Dentistry of New Jersey	2,551	6,561
45	Lindvall, Olle	Lund University	2,540	4,514
46	Jackson-Lewis, Vernice	Columbia University	2,529	3,995
47	Robbins, Trevor W	University of Cambridge	2,476	4,510
48	Chase, Thomas N	Hamilton Pharmaceuticals.	2,458	5,668
49	Vila, Miquel	University Hospital Vall d'Hebron	2,398	3,754
50	Greenamyre, J Timothy	University of Pittsburgh	2,391	3,751
51	Kordower, Jeffrey	Rush University Medical Center	2,386	4,203
52	Nutt, John G	Oregon Health & Science University	2,300	6,320
53	Tanner, Caroline M	The Parkinson's Institute	2,296	7,284
54	Polymeropoulos, Mihael H	Vanda Pharmaceuticals	2,268	4,531
55	Rothwell, John C	University College London	2,243	4,825
56	Frackowiak, Richard S J	University College London	2,186	4,507
57	Dawson, Valina L	Johns Hopkins University	2,170	3,646
58	Krack, Paul	University of Grenoble	2,136	5,143
59	Gasser, Thomas	University of Tübingen	2,121	5,926

Rank for Broad	Investigator	Affiliation	Broad impact	Total
	0 (1 W 16 U	י דד יויות וסד	2 104	5.217
00 61	Eidelberg David	Fringtain Institute for Medical Descent	2,104	3,317
62	Widner, Uslan	Lund University	2,102	4,085
62	Winner, Hakan	Lund University	2,100	3,933
63	wood, Nicholas w	University College London	2,090	6,021
64	Duvoisin, Roger C	University of Medicine and Dentistry of New Jersey	2,087	5,193
65	Poewe, werner	Innsbruck Medical University	2,062	5,892
66	Rascol, Olivier	University of Toulouse	2,043	6,144
67	Mayeux, Richard	Columbia University	2,036	4,919
68	Rehncrona, Stig	Lund University	2,035	4,069
69	Crossman, Alan R	University of Manchester	2,012	3,523
70	Maraganore, Demetrius M	Mayo Clinic – Minnesota	1,968	5,633
71	Watts, Ray L	University of Alabama at Birmingham	1,965	4,053
72	Müller, Thomas	St. Joseph Hospital Berlin-Weissensee	1,959	3,957
73	Stern, Matthew B	University of Pennsylvania	1,953	5,284
74	Hardy, John	University College London	1,932	4,818
75	Perry, Robert H	Newcastle University	1,892	2,729
76	Bonnet, Anne-Marie	Pitié - Salpêtrière University Hospital	1,872	5,131
77	Leenders, Klaus L	University Medical Center Groningen	1,861	3,771
78	Nagatsu, Toshiharu	Fujita Health University	1,860	3,104
79	Benazzouz, Abdelhamid	Université de Bordeaux	1,847	4,212
80	Brice, Alexis	Pitié - Salpêtrière University Hospital	1,826	4,802
81	Stoessl, A Jon	University of British Columbia	1,784	3,917
82	Przuntek, Horst	Ruhr-University of Bochum	1,778	3,583
83	Bonifati, Vincenzo	Erasmus University	1,772	5,611
84	Spillantini, Maria Grazia	University of Cambridge	1,757	2,313
85	Hauser, Robert A	University of South Florida	1,747	4,451
86	Johnson, William G	University of Medicine and Dentistry of New Jersey	1,735	3,686
87	Lazzarini, Alice M	University of Medicine and Dentistry of New Jersey	1.724	3.682
88	Albanese, Alberto	Università Cattolica del Sacro Cuore	1.703	4.674
89	Pahwa, Rajesh	University of Kansas	1.698	4.636
90	Minoshima, Satoshi	University of Washington	1.649	3.215
91	Cooper, J Mark	University College London	1.639	2,985
92	Wszolek, Zbigniew K	Mayo Clinic – Florida	1.633	4.232
93	Shoulson Ira	University of Rochester	1,626	5.371
94	Shults, Clifford W	University of California San Diego	1,624	3,827
95	Goedert Michel	University of Cambridge	1,620	2 226
96	LeWitt Peter	Wayne State University	1,520	4 553
97	McGeer, Edith G	University of British Columbia	1,585	2 460
98	Kieburtz Karl	University of Rochester	1,582	5 010
98	Cummings Leffrey I	University of California Los Angeles	1,582	2 962
100	McGeer, Patrick L	University of British Columbia	1,575	2,456

Table 2 (continued)

As part of the total-citations analysis, the new metric, "broad impact citations", is used as a measure of a given investigator's impact beyond the PD research community. In the broad-impact ranking, only the subset of an investigator's citations which originate from references in papers that are not part of this analysis (i.e. papers which fall outside of the PD literature) are considered.

For the 21 st century ranking, the same methods and considerations were applied to the data collection and analysis as described for the post-1984 total-citations ranking. The only difference is the temporal filter applied, which, for the 21 st century ranking, was PD papers published and indexed in WoS between 2001 and 2010.

RESULTS

Productivity and impact among PD investigators – the three metrics

As a first step in determining which PD investigators have contributed the most to the field since 1985, an article corpus was generated comprising 40,152 papers written in 21 languages appearing in 2,387 journals by authors representing 108 countries. From this corpus, a pool of the 300 most-cited PD researchers was generated. Those investigators who had five or fewer PD papers were excluded from the analysis. For each author in the pool of the 300 most-cited investigators, H-indices, total paper counts, "broad impact" citations

Table 3
Authors with highest H-indices calculated from same document base as used for the total-citation tabulations in Table 1 (total number of PD
papers in WoS and the main line of investigation from BiomedExperts for each scientist are also indicated)

PD F-indexInvestigator (* = Appared Man line of investigatonPDPDPDPD1Agid, YvesDopamine773253Lees, Andrew JLevodopa653655Olanov, C WarenLevodopa563656Brooks, DavidDopamine572597Gest, Christopher GLevodopa563188Quinn, Nial PLevodopa542289Hirsch, Eirome CDopamine5221710Koller, Willim CLevodopa5125511Jenner, PeterDopamine5016012Fahn, StanleyLevodopa4820114Obeso, Jose ALevodopa4820114Polks, JosephBottilianm Toxins4920414Tanner, Caroline MLevodopa4821117Riederer, PeterDopamine4615918Rascol, OlivierLevodopa4320119Benabid, Alim-LouisElectric Simulation Therapy444410Benabid, Alim-LouisElectric Simulation Therapy443323Mizuno, YoshikuniUbiquitin-Protein Ligases4322024Poewe, WernerLevodopa4322025Youdim, Mousa B HMonamire Oxidase432326Youdim, Mousa B HLevodopa4322027Larson, Andres MLevodopa381					
1 Agid, Yves Dopamine 77 365 1 Marsder, Chovid Dopamine 77 235 3 Lees, Andrew J Levodopa 65 365 5 Olanow, C Waren Levodopa 65 385 6 Brooks, David J Emission-Computed Tomography 57 259 7 Goetz, Christopher G Levodopa 56 318 8 Quinn, Nial P Levodopa 51 228 9 Hirsch, Etienne C Dopamine 50 160 12 Fahn, Stanley Levodopa 49 318 13 Jenner, Peter Dopamine 49 318 14 Poltak, Pierre Evodopa 48 201 14 Tomer, Caroline M Levodopa 48 201 15 Rascol, Olivér Levodopa 43 340 16 Benabid, Altim-Louis Electric Stimulation Therapy 44 230 16 Benabid, Altim-Louis	PD H-Index Rank	Investigator (* = Appeared in JAD Top 100 analysis [8])	Main line of investigation	PD H-Index	# of PD Papers
1 Marsden, C David Dopamine 7 245 3 Lees, Andrew J Levodopa 65 365 4 Lang, Anthony E Levodopa 58 367 5 Ollanov, C Warren Levodopa 58 247 6 Brooks, David J Envision-Computed Tomography 57 259 7 Goeze, Christopher G Levodopa 54 228 9 Hirsch, Etizan Dopamine 51 255 10 Koller, William C Levodopa 49 204 12 Jankovic, Joseph Botuliatum Toxins 49 204 14 Obeso, Jose A Levodopa 48 201 14 Pollak, Piere Electric Stimulation Therapy 48 211 17 Riedere, Pieter* Dopamine 46 159 18 Rascol, Olivier Levodopa 44 304 19 Beinkit, Allina Louis Electric Stimulation Therapy 44 324 20 </td <td>1</td> <td>Agid, Yves</td> <td>Dopamine</td> <td>77</td> <td>365</td>	1	Agid, Yves	Dopamine	77	365
3 Lees, Andrew J Levodopa 73 499 4 Lang, Anthrow F Levodopa 65 365 5 Olanow, C Warren Levodopa 55 365 6 Brooks, David J Emission-Computed Tomography 57 259 7 Goetz, Christopher G Levodopa 54 228 9 Hirsch, Etienne C Dopamine 52 171 Jenner, Peter Dopamine 50 160 12 Fahn, Stanley Levodopa 49 204 14 Poltak, Pierre Boutinum Toxins 49 204 14 Poltak, Pierre Evodopa 48 201 14 Poltak, Pierre Evodopa 48 201 17 Riodere, Peter* Dopamine 44 204 18 Rascol, Olivier Levodopa 43 324 19 Byrichund, Andres Dopamine 44 209 19 Pereshoreki, Serge 1-Methyl-1-2.3.6-tet	1	Marsden, C David	Dopamine	77	235
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6 Brooks, David J Ension-Computed Tomography 57 259 7 Gotz, Christopher G Levodopa 56 318 8 Quinn, Niall P Levodopa 56 318 9 Hirsch, Einene C Dopamine 51 228 10 Koller, William C Levodopa 51 255 11 Jenner, Piere Dopamine 50 160 12 Jankovic, Joseph Botulinum Toxins 49 204 14 Obeo, Jose A Levodopa 48 201 14 Tomer, Caroline M Levodopa 48 204 14 Tomer, Caroline M Levodopa 43 340 19 Benabid, Alme-Louis Electric Stimulation Therapy 44 90 19 Benabid, Alme-Louis Electric Stimulation Therapy 43 323 19 Benabid, Alme-Louis Electric Stimulation Therapy 44 83 23 Mizuon, Yoshikmi Ubiguim-Protein Ligases 43 324	5	Olanow, C Warren	Levodopa	58	247
7 Gotez, Christopher G Levodopa 56 318 8 Quinn, Nill P Levodopa 52 177 10 Koller, William C Dopamine 51 252 177 11 Jenner, Peter Dopamine 59 160 12 Fahn, Stanley Levodopa 49 318 14 Poltak, Pierre Electric Stimulation Therapy 48 201 14 Tamer, Caroline M Levodopa 48 211 17 Ricelerer, Peter* Dopamine 46 153 18 Racol, Olivier Levodopa 44 90 19 Benahid, Aliran-Louis Electric Stimulation Therapy 44 184 19 Opertel, Wolfgang H Levodopa 43 324 23 Mitzuno, Yoshikuni Ubiquith-Protein Ligases 43 323 24 Nott, John G Levodopa 42 137 25 Poewe, Werner Levodopa 43 333	6	Brooks, David J	Emission-Computed Tomography	57	259
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9 Hirsch, Eienne C Dopamine 52 175 10 Kuller, William C Levodopa 50 160 12 Fahn, Stanley Levodopa 49 204 12 Jankovic, Joseph Borulinum Toxins 49 318 14 Poltak, Pierre Electric Stimulation Therapy 48 201 14 Tumore, Caroline M Levodopa 48 211 17 Ricederer, Peter* Dopamine 46 159 18 Raccol, Olivier Levodopa 44 53 340 19 Benabid, Alim-Louis Electric Stimulation Therapy 44 45 340 19 Bricklund, Anders Doparnine 44 83 324 23 Mizuno, Yoshikuri Ubiquitn-Protein Ligaes 43 324 23 Nutz, John G Levodopa 42 137 24 Poewe, Werner Levodopa 42 137 25 Poewe, Werner Levodopa 42	8	Quinn, Niall P	Levodopa	54	228
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12Fahn, StanleyLevodopa4920412Janković, JosephBottlinum Toxins4931814Obeso, Jose ALevodopa4820114Pollak, PierreElectrić Stimulation Therapy4819614Tamer, Caroline MLevodopa4821117Riedere, Peter*Dopamine4615918Rascol, OlivierLevodopa4534019Benabid, Alim-LouisElectric Stimulation Therapy449019Ortet, Wolfgang HLevodopa449019Ortet, Wolfgang HLevodopa4332423Mizuon, YoshikuniUbiquitin-Protein Ligases4332423Nutt, John GLevodopa4332623Poewe, WernerLevodopa4333227Chase, Thomas NLevodopa4213327Chase, Thomas NLevodopa4213327Larsen, Jan PetterNeuropsychological Tests4210521Larsen, Jan PetterNeuropsychological Tests3913633Jelinger, Kurt A*Autopsy3913634Larsen, Jan PetterNeuropsychological Tests3810335Mayeux, Richard*Apolipoproteins E3810335Mayeux, Richard*Apolipoproteins E3810335Stenparia, Authory HMitachonal analysis3516636Crasser, T	11	Jenner, Peter	Dopamine	50	160
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14 Tanner, Caroline M Levodopa 48 211 17 Riederr, Peter* Dopamine 46 159 18 Rascol, Olivier Levodopa 45 340 19 Benbåid, Alm-Louis Electric Stimulation Therapy 44 154 19 Björklund, Anders Dopamine 44 279 19 Octrel, Wolfgang H Levodopa 43 324 23 Muzuno, Yoshikuni Ubiquitin-Protein Ligases 43 326 23 Nott, John G Levodopa 42 137 23 Poewe, Werner Levodopa 42 137 24 Chase, Thomas N Levodopa 42 137 27 Chase, Thomas N Levodopa 40 149 28 Youdim, Moussa B H Monoamine Oxidase 40 156 27 Larsen, Jan Petter Neuropsychological Tests 42 165 31 Calne, Donald B Levodopa 40 149 33 Bonfati, Wincenzo Ubiquitin-Protein Ligases 39 116 34 Larsen, Jankind, Dag Neuropsychological Tests 38 167 35 Stern, Matthew B Levodopa 38 <td>14</td> <td>Pollak, Pierre</td> <td>Electric Stimulation Therapy</td> <td>48</td> <td>196</td>	14	Pollak, Pierre	Electric Stimulation Therapy	48	196
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18 Rascol, Olivier Levodopa 45 340 19 Benabid, Alm-Louis Electric Stimulation Therapy 44 154 19 Ocrtel, Wolfgang H Levodopa 44 90 19 Przedborski, Serge 1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine 44 83 23 Mizuno, Yoshikuni Ubiquith-Protein Ligases 43 324 23 Nott, John G Levodopa 43 326 23 Nott, John G Levodopa 43 336 23 Youdim, Moussa B H Monoamine Oxidase 42 137 27 Chase, Thomas N Levodopa 42 133 27 Larsen, Jan Petter Neuropsychological Tests 42 165 21 Calne, Donald B Levodopa 40 156 31 Langston, J William 1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine 40 156 33 Boinfati, Vincenzo Ubiquith-Protein Ligases 39 136 35 Aaraland, Dag Neuropsychological Tests 38 103 36 Schapira, An	17	Riederer, Peter*	Dopamine	46	159
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82 Rocca, Walter A Risk Factors 29 126 82 Rothwell John C Transcranial Magnetic Stimulation 29 85
82 Rothwell John C Transcranial Magnetic Stimulation 29 85
82 Vieregge, Peter Pedigree (genealogy) 29 96
82 Wolters, Erik C Dopamine 29 138
94 Albanese, Alberto Botulinum Toxins 28 92
94 Brundin, Patrik Dopamine 28 65
94 Gwinn-Hardy, Katrina Synucleins 28 77
94 Hurtig, Howard I Levodopa 28 103
94 Kurlan, Roger Levodopa 28 65
94 Lindvall, Olle Brain Tissue Transplantation 28 65
94 Marek, Kenneth Dopamine Plasma Membrane Transport Proteins 28 136
94 Perry, Robert H* Lewy Bodies 28 60
94 Shoulson, Ira Levodopa 28 87
94 Stebbins, Glenn T Severity of Illness Index 28 106

Table 3 (continued)

(see the section below), and total citations were calculated. Finally top-100 rankings for total citations and H-Index were generated.

Further refining impact measures – broad impact citations

Because of the increasing phenomenon of advances having implications beyond a particular disease, part of the analysis was dedicated to evaluating methods of differentiating, algorithmically, those authors who contribute work that has impact beyond the PD community. One datum generated by HistCite is the number of "internal" citations an author has generated within a given set of papers. Applying the concept of internal citations to the PD literature under analysis, one is able to split each investigator's citations into those citations accrued from papers within the PD literature and those citations arising from references in papers outside of the PD literature. It thus becomes possible to calculate how many citations a given investigator has if only citations from papers outside the PD literature were

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Most-cited authors from 2001 to 2010 based on citation rates for PD papers indexed in Thomson Reuters ISI WoS and aggregated in Thomson Reuters HistCite (institutional affiliation, rank from Table 1, and rise or fall in rank between Tables 1 and 4 indicated). (n/a) indicates new names that appear in the most cited of the last 10 years who did not appear in the 25 year analysis

Rank for	Investigator	Affiliation	Total	Table 1	Rise or fall
total	-		citations	total	in Rank
citations				citations	from Table 1
				rank	to Table 4
1	Lang, Anthony E	Toronto Western Research Institute	7,464	4	3
2	Farrer, Matthew J	Mayo Clinic - Florida	6,470	21	19
3	Lees, Andrew J	University College London	5,999	1	-2
4	Olanow, C Warren	Mount Sinai School of Medicine	5,905	5	1
5	Singleton, Andrew	National Institute of Aging - NIH	5,007	50	45
6	Przedborski, Serge	Columbia University	4,477	29	23
7	Wood, Nicholas W	University College London	4,396	33	26
8	Pollak, Pierre	Joseph Fourier University	4,311	13	5
9	Benabid, Alim-Louis	Joseph Fourier University	4,123	10	1
10	Poewe, Werner	Innsbruck Medical University	4,107	35	25
11	Jankovic, Joseph	Baylor College of Medicine	4,094	18	7
12	Fahn, Stanley	Columbia University	3,985	9	-3
13	Hardy, John	University College London	3,964	56	43
14	Agid, Yves	Pitié - Salpêtrière University Hospital	3,759	3	-11
15	Lozano, Andres M	University of Toronto	3,700	16	1
16	Albanese, Alberto	Università Cattolica del Sacro Cuore	3,691	61	45
17	Goetz, Christopher G	Rush University Medical Center	3,690	11	-6
18	Dawson, Ted M	Johns Hopkins University	3,687	65	47
19	Cookson, Mark R	National Institute on Aging - NIH	3,560	n/a	n/a
20	Maraganore, Demetrius M	Mayo Clinic - Minnesota	3,504	41	21
21	Aarsland, Dag	Stavanger University Hospital	3,441	69	48
22	Brooks, David J	Imperial College London	3,438	6	-16
23	Stoessl, A Jon	University of British Columbia	3,391	87	64
24	Koller, William C	University of North Carolina	3,313	15	-9
25	Kachergus, Jennifer	Mayo Clinic - Florida	3,300	n/a	n/a
26	Bonifati, Vincenzo	Erasmus University	3,299	42	16
27	Gasser, Thomas	University of Tübingen	3,170	34	7
28	Brice, Alexis	Pitié - Salpêtrière University Hospital	3,136	57	29
29	Tolosa, Eduardo	University of Barcelona	3,115	78	49
30	Gwinn-Hardy, Katrina	National Institute of Neurological Disorders and Stroke - NIH	3,073	98	68
31	Quinn, Niall P	University College London	3,049	12	-19
32	Stern, Matthew B	University of Pennsylvania	3,015	46	14
33	Jackson-Lewis, Vernice	Columbia University	2,929	83	50
34	Pahwa, Rajesh	University of Kansas	2,915	62	28
35	Mizuno, Yoshikuni	Juntendo University School of Medicine	2,892	8	-27
36	Obeso, Jose A	University of Navarra	2,887	22	-14
37	Krack, Paul	Joseph Fourier University	2,874	48	11
38	Dawson, Valina L	Johns Hopkins University	2,865	97	59
39	Eidelberg, David	Feinstein Institute for Medical Research	2,816	60	21
40	Kieburtz, Karl	University of Rochester	2,751	53	13
41	Watts, Ray L	University of Alabama at Birmingham	2,702	81	40
42	Braak, Heiko	University of Ulm	2,672	n/a	n/a
43	Nutt, John G	Oregon Health & Science University	2,650	31	-12
44	Beal, M Flint	Cornell University	2,629	90	46
45	Larsen, Jan Petter	Stavanger University Hospital	2,622	51	0
46	Rascol, Olivier	University of Toulouse	2,607	32	-14
4/	Wszolek, Zbigniew K	Mayo Clinic - Florida	2,584	73	26
48	Del Iredici K	University of Ulm	2,558	n/a	n/a
49	Nussbaum, Robert L	University of California San Francisco	2,542	38	-11
50	Vila, Miquel	University Hospital Vall d'Hebron	2,533	92	42
51	Uertei, Wolfgang H	I ne Philipps University	2,525	45	-6 29
52 52	Hattori, Nobutaka	Juntendo University School of Medicine	2,500	24 m/-	-28
55	Kiein, Unristine	University of Lubeck	2,470	n/a	n/a
54 55	Tanner, Caroline M	I ne Parkinson's Institute	2,378	19	-35
33 57	Bonnet, Anne-Marie	Plue - Salpetriere University Hospital	2,336	49	-6 (
30	isacson, Ole	Harvaru University	2,331	n/a	n/a

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Rank for	Investigator	Affiliation	Total	Table I	Rise or fall
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citations				rank	to Table 4
57	Ondo William G	Baylor College of Medicine	2 330	n/a	
58	Volkmann Jens	Christian- Albrechts University	2,330	n/a	n/a
59	Hirsch Etienne C	Pitié - Salnêtrière University Hospital	2,323	14	-45
60	Barker, Roger A	University of Cambridge	2,258	n/a	n/a
61	Healy Daniel G	University College London	2,256	n/a	n/a
62	Rüb Udo	Goethe University	2.242	n/a	n/a
63	Jenner Peter	King's College London	2,215	7	-56
64	DeLong, Mahlon R	Emory University	2.207	43	-21
65	Deuschl, Günther	Christian-Albrechts University	2,204	n/a	n/a
66	Shoulson Ira	University of Rochester	2,169	44	-22
67	Abou-Sleiman Patrick M	University College London	2,153	n/a	n/a
68	Dickson, Dennis W	Mayo Clinic - Florida	2,141	n/a	n/a
69	Trojanowski, John O	University of Pennsylvania	2.115	82	13
70	Stocchi, Fabrizio	IRCCS San Raffaele	2.053	n/a	n/a
71	Oostra. Ben A	Erasmus University	2.043	n/a	n/a
72	Burn, David J	Newcastle University	2.035	n/a	n/a
73	Youdim, Moussa B H	Technion – Israel Institute of Technology	2.009	25	-47
74	Marek, Kenneth	Institute for Neurodegenerative Disorders	1.975	76	3
75	de Vos. Rob A I	Laboratorium Pathologie Oost Nederland	1,974	n/a	n/a
76	Giladi, Nir	Tel Aviv Sourasky Medical Center Sackler School of Medicine	1,970	n/a	n/a
77	Shults, Clifford W	University of California San Diego	1,935	89	13
78	Adler, Charles H	Mayo Clinic - Arizona	1,934	n/a	n/a
79	Teismann, Peter	University of Aberdeen	1,932	n/a	n/a
80	McKeith, Ian G	Newcastle University	1,929	n/a	n/a
81	Berg, Daniela	University of Tübingen	1,910	n/a	n/a
82	Hauser, Robert A	University of South Florida	1,895	70	-11
83	McNaught, Kevin St P	Mount Sinai School of Medicine	1,884	n/a	n/a
84	Brown, Peter	University of Oxford	1,862	n/a	n/a
85	Baptista, Melisa J	University of Sheffield	1,854	n/a	n/a
86	Vitek, Jerrold L	University of Minnesota	1,848	n/a	n/a
87	Meco, Giuseppe	Sapienza University	1,823	88	1
87	Schapira, Anthony H V	University College London	1,823	28	-59
89	Björklund, Anders	Lund University	1,810	23	-66
90	Fraix, Valérie	Joseph Fourier University	1,790	n/a	n/a
91	Lansbury, Peter T	Harvard University	1,778	100	9
92	Greenamyre, J Timothy	University of Pittsburgh	1,775	93	1
93	Tieu, Kim	University of Rochester	1,758	n/a	n/a
94	Bentivoglio, Anna Rita	Università Cattolica del Sacro Cuore	1,755	n/a	n/a
95	Gilks, William P	Trinity College - Dublin	1,749	n/a	n/a
96	Schwarzschild, Michael A	Harvard University	1,740	n/a	n/a
97	Sampaio, Cristina	Lisboa Medical University	1,713	n/a	n/a
98	Vieregge, Peter	Clinic of Lippe-Lemgo	1,690	n/a	n/a
99	Houeto, Jean-Luc	University of Poitiers	1,677	n/a	n/a
100	Kulisevsky, Jaime	University of Barcelona	1,676	n/a	n/a

Table 4 (continued)

(n/a) indicates new names that appear in the most cited of the last 10 years who did not appear in the 25 year analysis

considered (as opposed to the default method of considering all citations regardless of the topic of the citing paper). By measuring only external citations, one can identify those researchers for whom the vast majority of citations come from outside the PD literature as opposed to those whose citations stem mainly from papers within the PD literature. We propose "broad impact" citations as a measure of the impact which a given investigator's PD work has outside PD research.

Impact in the 21st century

In order to get a sense for how the PD "impact landscape", might have changed in the 21st century, a total-citations ranking was generated using only the subset of the papers from the original analysis published between 2001 and 2010. Employing the same methodology as described above, an article corpus was generated comprising 27,063 papers written in 20 languages appearing in 1,740 journals by authors representing 97 countries.

CONCLUSIONS

Most names in Tables 1–3 will be clearly recognized by the majority of PD investigators as being "superstars" (for example the late David Marsden) in the PD community. By contrast, however, many of the investigators appearing in Table 4 are likely to be less well known. The appearance of such names in a top-100 PD ranking is evidence that there are a considerable number of "rising stars" who, in the last decade, have made significant contributions to the PD literature, often through molecular or genetic approaches. Given the more modern nature of their lines of investigation, these investigators are not nearly as prominent when studying a longer timeframe.

An interesting direction for future study that naturally follows the work presented in this paper would be a more in depth examination of those areas of basic science which have contributed heavily to the current understanding of PD. An example of this would be to attempt to quantify the degree to which genomics or studies of mitochondrial dysfunction and oxidative stress have inspired new lines of investigation within the PD research community.

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