Journal of Parkinson's Disease 1 (2011) 3–13
DOI 10.3233/JPD-2011-10021
IOS Press

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 most-highly 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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ISSN 1877-7171/11/$27.50

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 H-index 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 Total Citations	Investigator (* = Appeared in JAD Top 100 analysis [8])	Affiliation	Total citations	# of PD 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, Pierre	Joseph Fourier University	9,008	196
14	Hirsch, Etienne C	Pitié - Salpêtrière University Hospital	8,891	177
15	Koller, William C	University of North Carolina	8,853	255
16	Lozano, Andres M	University of Toronto	8,349	165
17	Riederer, Peter*	Universität Würzburg	8,242	159
18	Jankovic, Joseph	Baylor College of Medicine	8,023	318
19	Daniel, Susan E	University College London	7,284	211
19	Tanner, Caroline M	The Parkinson's Institute	7,284	55
21	Farrer, Matthew J	Mayo Clinic - Florida	7,241	237
22	Obeso, Jose A	University of Navarra	7,173	201
23	Björklund, Anders	Lund University	7,040	90
24	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	Bonnet, Anne-Marie	Pitié - Salpêtrière University Hospital	5,131	116
50	Singleton, Andrew	National Institute of Aging - NIH	5,108	117
51	Larsen, Jan Petter	Stavanger University Hospital	5,053	170
52	Hughes, Andrew J	University of Melbourne	5,017	47
53	Kieburtz, Karl	University of Rochester	5,010	92
54	Mayeux, Richard*	Columbia University	4,919	103
55	Rothwell, John C	University College London	4,825	85
56	Hardy, John*	University College London	4,818	131
57	Brice, Alexis	Pitié - Salpêtrière University Hospital	4,802	135

Table 1 (*continued*)

Rank for Total Citations	Investigator (* = Appeared in JAD Top 100 analysis [8])	Affiliation	Total citations	# of PD 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

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.

Table 2
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 impact citations	Investigator	Affiliation	Broad impact citations	Total 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 - Salpêtrière 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 Würzburg	5,012	8,242
11	Youdim, Moussa B H	Technion – Israel Institute of Technology	4,322	6,667
12	Benabid, Alim-Louis	Joseph Fourier University	4,234	9,316
13	Björklund, Anders	Lund University	4,077	7,040
14	Przedborski, Serge	Columbia University	3,886	6,512
15	Pollak, Pierre	University of Grenoble	3,727	9,008
16	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
21	Schapira, Anthony H V	University College London	3,443	6,515
22	Hattori, Nobutaka	Juntendo University School of Medicine	3,405	6,864
23	Dexter, David T	Imperial College London	3,386	5,846
24	Javoy-Agid, France	Pitié - Salpêtrière University Hospital	3,368	5,697
25	Jellinger, Kurt A	University of Vienna	3,268	5,797
26	Singleton, Andrew	National Institute of Aging - NIH	3,222	5,108
27	Langston, J 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

Table 2 (*continued*)

Rank for Broad impact citations	Investigator	Affiliation	Broad impact citations	Total citations
60	Oertel, Wolfgang H	The Philipps University	2,104	5,317
61	Eidelberg, David	Feinstein Institute for Medical Research	2,102	4,683
62	Widner, Håkan	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	1,597	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, Jeffrey L	University of California, Los Angeles	1,582	2,962
100	McGeer, Patrick L	University of British Columbia	1,575	2,456

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 H-Index Rank	Investigator (* = Appeared in JAD Top 100 analysis [8])	Main line of investigation	PD H-Index	# of PD Papers
1	Agid, Yves	Dopamine	77	365
1	Marsden, C David	Dopamine	77	235
3	Lees, Andrew J	Levodopa	73	459
4	Lang, Anthony E	Levodopa	65	365
5	Olanow, C Warren	Levodopa	58	247
6	Brooks, David J	Emission-Computed Tomography	57	259
7	Goetz, Christopher G	Levodopa	56	318
8	Quinn, Niall P	Levodopa	54	228
9	Hirsch, Etienne C	Dopamine	52	177
10	Koller, William C	Levodopa	51	255
11	Jenner, Peter	Dopamine	50	160
12	Fahn, Stanley	Levodopa	49	204
12	Jankovic, Joseph	Botulinum Toxins	49	318
14	Obeso, Jose A	Levodopa	48	201
14	Pollak, Pierre	Electric Stimulation Therapy	48	196
14	Tanner, Caroline M	Levodopa	48	211
17	Riederer, Peter*	Dopamine	46	159
18	Rascol, Olivier	Levodopa	45	340
19	Benabid, Alim-Louis	Electric Stimulation Therapy	44	154
19	Björklund, Anders	Dopamine	44	90
19	Oertel, Wolfgang H	Levodopa	44	279
19	Przedborski, Serge	1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine	44	83
23	Mizuno, Yoshikuni	Ubiquitin-Protein Ligases	43	324
23	Nutt, John G	Levodopa	43	220
23	Poewe, Werner	Levodopa	43	326
23	Youdim, Moussa B H	Monoamine Oxidase	43	133
27	Chase, Thomas N	Levodopa	42	137
27	Farrer, Matthew J	Genetic Predisposition to Disease	42	237
27	Larsen, Jan Petter	Neuropsychological Tests	42	170
27	Lozano, Andres M	Deep Brain Stimulation	42	165
31	Calne, Donald B	Levodopa	40	156
31	Langston, J William	1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine	40	149
33	Bonifati, Vincenzo	Ubiquitin-Protein Ligases	39	136
33	Jellinger, Kurt A*	Autopsy	39	116
35	Aarsland, Dag	Neuropsychological Tests	38	167
35	Mayeux, Richard*	Apolipoproteins E	38	103
35	Schapira, Anthony H V	Mitochondrial DNA	38	170
35	Stern, Matthew B	Levodopa	38	212
39	Bonnet, Anne-Marie	Levodopa	37	116
39	Maraganore, Demetrius M	Genetic Predisposition to Disease	37	153
41	Eidelberg, David	Brain Mapping	36	203
41	Javoy-Agid, France	Dopamine	36	78
43	Ahlskog, J Eric	Levodopa	35	145
43	Côté, Lucien J	Neuropsychological Tests	35	106
43	Friedman, Joseph H	Clozapine	35	165
43	Gasser, Thomas	DNA Mutational Analysis	35	160
43	LeWitt, Peter	Levodopa	35	113
43	Marder, Karen	Neuropsychological Tests	35	128
43	Rajput, Ali H	Levodopa	35	126
50	Crossman, Alan R	Levodopa	34	92
50	Golbe, Lawrence I	alpha-synuclein	34	84
50	Hubble, Jean P	Levodopa	34	90
50	Rinne, Juha O	Emission Computed Tomography	34	90
54	Daniel, Susan E	Lewy Bodies	33	55
54	Hardy, John*	Genetic Predisposition to Disease/tau Proteins	33	131
54	Hattori, Nobutaka	Ubiquitin-Protein Ligases	33	228
54	Krack, Paul	Electric Stimulation Therapy	33	101
54	Montastruc, Jean-Louis	Levodopa	33	127
54	Pahwa, Rajesh	Deep Brain Stimulation	33	193

Table 3 (*continued*)

PD H-Index Rank	Investigator (* = Appeared in JAD Top 100 analysis [8])	Main line of investigation	PD H-Index	# of PD Papers
54	Pfeiffer, Ronald F	Levodopa	33	114
54	Rinne, Urpo K	Levodopa	33	101
54	Tolosa, Eduardo	Levodopa	33	224
63	Brice, Alexis	Pedigree (genealogy)	32	135
63	Melamed, Eldad	Dopamine	32	154
63	Watts, Ray L	Genetic Predisposition to Disease	32	151
63	Weiner, William J	Levodopa	32	172
67	Burn, David J	Differential Diagnosis	31	160
67	Factor, Stewart A	Levodopa	31	117
67	Singleton, Andrew	Genetic Predisposition to Disease	31	117
67	Stocchi, Fabrizio	Lisuride	31	179
67	Wood, Nicholas W	Pedigree (genealogy)	31	144
67	Wszolek, Zbigniew K	Pedigree (genealogy)	31	179
73	Brotchie, Jonathan M	Levodopa	30	136
73	Dawson, Ted M	Nitric Oxide Synthase	30	77
73	DeLong, Mahlon R	Brain Mapping	30	73
73	Giladi, Nir	Levodopa	30	245
73	Hauser, Robert A	Levodopa	30	181
73	Klein, Christine	DNA Mutational Analysis	30	171
73	McKeith, Ian G*	Lewy Bodies	30	81
73	Meco, Giuseppe	Levodopa	30	96
73	Wenning, Gregor	Differential Diagnosis	30	105
82	Beal, M Flint*	Mitochondria	29	61
82	Deuschl, Günther	Deep Brain Stimulation	29	140
82	Dhawan, Vijay	Emission-Computed Tomography	29	126
82	Dubois, Bruno	Neuropsychological Tests	29	77
82	Jackson-Lewis, Vernice	Dopamine	29	48
82	Kieburtz, Karl	Neuropsychological Tests	29	92
82	Korczyn, Amos D	Risk Factors	29	127
82	Nagatsu, Toshiharu	Tyrosine 3-Monooxygenase	29	81
82	Rocca, Walter A	Risk Factors	29	126
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

(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

Table 4
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 total citations	Investigator	Affiliation	Total citations	Table 1 total citations rank	Rise or fall in Rank from Table 1 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	6
46	Rascol, Olivier	University of Toulouse	2,607	32	–14
47	Wszolek, Zbigniew K	Mayo Clinic - Florida	2,584	73	26
48	Del Tredici 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	Oertel, Wolfgang H	The Philipps University	2,525	45	–6
52	Hattori, Nobutaka	Juntendo University School of Medicine	2,500	24	–28
53	Klein, Christine	University of Lübeck	2,470	n/a	n/a
54	Tanner, Caroline M	The Parkinson's Institute	2,378	19	–35
55	Bonnet, Anne-Marie	Pitié - Salpêtrière University Hospital	2,336	49	–6
56	Isacson, Ole	Harvard University	2,331	n/a	n/a

Table 4 (*continued*)

Rank for total citations	Investigator	Affiliation	Total citations	Table 1 total citations rank	Rise or fall in Rank from Table 1 to Table 4
57	Ondo, William G	Baylor College of Medicine	2,330	n/a	n/a
58	Volkmann, Jens	Christian- Albrechts University	2,323	n/a	n/a
59	Hirsch, Etienne C	Pitié - Salpêtrière University Hospital	2,297	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 Q	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

(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.

ACKNOWLEDGMENTS

The authors would like to thank the referees for their insightful comments.

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