Current Comments

Journal Citation Studies. 37. Using Citation Analysis to Study the Neuroscience Journals

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The growth of neuroscience has been phenomenal. Membership in the Society for Neuroscience, established in 1969, has already reached 7,600, and the literature of this emergent field has grown extensively. Advances in neuroscience have been so rapid that it is easy to forget how far this field has progressed.

That neuroscience crosses many disciplines is a truism. So when I began work on a chapter on the neurology literature for the *Handbook of Clinical Neurology*, I and my friend Pierre Vinken, president of Elsevier, the publishing company that produces the *Handbook*, concluded that limiting the study to clinical neurology journals would be too restrictive. The following paper, which will be published in volume 44 of the *Handbook* later this year, emerged after considerable debate over which journals should be included.

We finally agreed on a list of 89 journals which Vinken identified as most relevant to the *Handbook*'s readers. Clearly, this prescription does not adequately reflect the full scope of neuroscience, which overlaps with the behavioral sciences in significant ways. When ISI® finally mounts a neuroscience online data base for the ISI Search Network, we will have to draw on papers from a number of fields. The need for multidisciplinary coverage in a neuroscience data base is supported by the fact that the milestone neuroscience papers forming the core of many research fronts in our existing data bases[1-3] are published in journals representing a broad range of disciplines. However, as neuroscience becomes more sharply focused, we can expect that Bradford's law will apply to the literature of this field.[4] A small number of journals will account for a large percentage of the most important papers published.

Although Dominick P. Purpura, Rose F. Kennedy Center for Research in Mental Retardation and Human Development, Albert Einstein College of Medicine, New York, refers to the present era as the "golden age of neuroscience,"[5] confusion over the precise definition of neuroscience is even reflected in the name of the institution that provides the majority of financial support to neuroscience research. It is indicative that the name of the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) still emphasizes "neurology" rather than neuroscience. This institute, according to William B. Matthews, Jr., NINCDS, provides funds for more than 2,000 research projects in, or related to, neuroscience.[6]

Since neuroscience's progress has been so rapid in the past three decades, it would have been interesting and useful to have used our data bases to study the growth of the neuroscience literature in the same manner that we studied the

growth of biochemical literature.[7] Perhaps we will perform that study when we are ready to launch the neuroscience data base I mentioned earlier.

In fairness to those readers who are not familiar with the burgeoning literature on citation analysis, it is important to note that not everyone accepts impact as an adequate method for ranking the importance of journals in a particular discipline. A recent example of this is a critique by M. Boor, Brown University.[8] His main objection is to using the last few years of data for measuring impact. Presumably, rankings might change if the cumulative effect of "premature" theories, such as Freud's—that is, theories that aren't cited until many years after they are introduced in the literature—were taken into account. We have used modified measures of impact within certain fields. In general, the results are not significantly different. However, any reader can refer to the *Science Citation Index*® *Journal Citation Reports*® to compute impacts using different years as a baseline.

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Citation analysis of neuroscience journals: What they cite and what cites them*

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Since World War II, a number of disciplines have experienced rapid growth. This has usually been accompanied by an increase in the number of articles published. Often this, in turn, has spawned a proliferation of new journals, as well as numerous secondary information services designed to help researchers and clinical investigators locate and retrieve the information directly related to their investigations. In the late 1950s the Institute for Scientific Information® (ISI®), the publisher of *Current Contents®*, developed an information retrieval system based on citation indexing (Garfield 1979a). Through the *Science Citation Index®* (*SCI®*), the user is able to identify where any published article or book has been cited, or quoted, in the subsequent literature. Thus, a searcher who has found a particularly relevant article through *Excerpta Medica* or *Index Medicus*, may determine through the *SCI* whether further work has been done on this particular theme.

The *SCI* data base has also been used to measure the citation frequency of particular articles, authors, and institutions, as well as of individual journals. Each annual *SCI* includes a separate volume called the *Journal Citation Reports®* (*JCR®*) which includes citation data on each of the thousands of journals covered by the *SCI*. The *JCR* includes a number of statistical breakdowns on journals, including the number of citations they received in a given year, the number of articles (source items) they published, and the journals they cited, and were cited by. So, using the *JCR*, we can determine which journals have been cited by authors who have published papers in *Brain Research*, *Neurology*, or any other journal or group of journals.

The Institute for Scientific Information has used the *JCR* to perform a number of citation analyses to examine the citation patterns and identify the core journals of several medical disciplines (Garfield 1977a, b, c, 1979b, 1982a). Following the pattern established in those studies, we have made an analysis of neuroscience journals. Using data contained in the 1980 edition of the *SCI Journal Citation Reports*, we have treated a large group of neuroscience journals as if they comprised a single 'Macro Journal of Neuroscience.' In this way, we have determined which journals cite and, in turn, are cited by, the core neuroscience journals.

The 89 journals in this study are presented in Table 1, along with the date that each began publication. *Archiv für Psychiatrie und Nervenkrankheiten*, established in 1868, is the oldest. This list is not absolutely comprehensive. It neither includes every neuroscience journal, nor every journal that publishes neuroscience papers. However, the journals included in the *SCI* data base have been chosen by analyzing citation frequency data for many years. Consequently, we are confident that the most significant neuroscience journals have been included (Garfield 1981a). This analysis will demonstrate the validity of this method.

The 89 core neuroscience journals published 9278 papers in 1980. This represents 2.67% of the 347,707 papers included in the 1980 *JCR*. Actually, the number of 'source' items covered in the *SCI* in 1980 was about 520,000, but for the purpose of these studies we have eliminated items such as meetings, abstracts, letters, and editorials. Thus, only the research, review, or other substantive articles published by each journal have been considered in this study.

Source items in the 1980 *JCR* also included almost 7 million references. Of these, 3.53% were references from the neuroscience core. The articles in these particular journals also included an average of 26 references. This is considerably higher than the average of 19.6 references for the entire *JCR* file. The number of references included in papers in a given field is usually related to the number of papers already published as well as the number of people working in that discipline. For example, in a recent study, ISI found that the math literature is relatively small. Consequently, the average math article contained

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Table 1: Neuroscience core journals.

Acta Neurobiologiae Experimentalis	1928
Acta Neurochirurgica	1950
Acta Neurologica Scandinavica	1961
Acta Neuropathologica	1961
Activitas Nervosa Superior	1959
Advances in Biochemical Psychopharmacology	1969
Advances in Neurochemistry	1975
Advances in Neurology	1973
Advances in Neurosurgery	1973
Advances in Sleep Research	1974
American Journal of Mental Deficiency	1876
Annals of Neurology	1977
Applied Neurophysiology	1938
Archiv für Psychiatrie und Nervenkrankheiten	*1868*
Archives of Neurology	1959
Behavioral and Neural Biology—An International Series (formerly Communications in Behavioral Biology; Behavioral Biology)	1968
Brain	1878
Brain, Behavior and Evolution	1968
Brain Research	1966
Brain Research Bulletin	1976
Canadian Journal of Neurological Sciences	1974
Child's Brain	1957
Clinical Electroencephalography	1970
Clinical Neurology and Neurosurgery	1975
Clinical Neuropharmacology	1976
Clinical Neurosurgery	1953
Cortex	1964
Developmental Neuroscience	1978
Developmental Medicine and Child Neurology	1958
Developments in Neuroscience	1977
Electroencephalography and Clinical Neurophysiology—EEG Journal	1949
Epilepsia	1959
Essays in Neurochemistry and Neuropharmacology	1977
European Neurology	1968
Experimental Brain Research	1965
Experimental Neurology	1959
Fortschritte der Neurologie, Psychiatrie und Ihrer Grenzgebiete	1931
Frontiers in Neuroendocrinology	1969
Headache	1961
Hearing Research	1978
International Brain Research Organization Monograph Series	1975
International Journal of Neuroscience	1970
International Review of Neurobiology	1959
Journal of Comparative Neurology	1891
Journal of Mental Deficiency Research	1957
Journal of Neural Transmission	*1950*
Journal of Neurobiology	1969
Journal of Neurochemistry	1956
Journal of Neurocytology	1972
Journal of Neurological Sciences	1964
Journal of Neurology—Zeitschrift für Neurologie	1891
Journal of Neurology, Neurosurgery and Psychiatry	1926
Journal of Neuropathology and Experimental Neurology	1942
Journal of Neurophysiology	1938
Journal of Neuroscience Research	1975
Journal of Neurosurgery	1944
Methods in Psychobiology	1972
Muscle & Nerve	1978
Nervenarzt	1928
Neuro-Chirurgie	1955
Neurochemical Research	1976
Neurochirurgia	1958
Neuroendocrinology	1965
Neurology	1951
Neuropathology and Applied Neurobiology	1975
Neuropediatrics (formerly Neuropädiatrie)	1969
Neuropharmacology	1962
Neuropsychobiology	1975
Neuropsychologia	1963
Neuroradiology	1970
Neuroscience	1976
Neuroscience and Biobehavioral Reviews	1977
Neuroscience Letters	1975
Neurosciences Research Program Bulletin	1963
Neurotoxicology	1978
Perspectives in Neurolinguistics and Psycholinguistics: A Series of Monographs and Treatises	1977
Progress in Brain Research	1963
Progress in Clinical Neurophysiology	1977
Progress in Neurobiology	1973
Progress in Neurological Surgery	1966
Psychoneuroendocrinology	1976
Psychopharmacology (formerly Psychopharmacologia)	1959
Research Publications: Association for Research in Nervous and Mental Disease	1920
Reviews of Neuroscience	1974
Revue Neurologique	1893
Schweizer Archiv für Neurologie, Neurochirurgie und Psychiatrie	1917
Trends in Neurosciences	1978
Zhurnal Nevropatologii I Psikhiatrii Imeni S.S. Korsakova	1901
Zhurnal Vysshei Nervnoi Deyatel'nosti Imeni I.P. Pavlova	1951

10.5 references (Garfield 1982b). Biochemistry articles, on the other hand, contained an average of 23.4 (Garfield 1979b) references.

The neuroscience journals in the ISI data base received 163,877 citations in 1980. This represents slightly more than 3% of the 5,348,444 citations received by all journals in the *JCR*. Almost half (48%) of the citations received by the 75 core neuroscience journals in the data base were to just six journals—*Brain Research* (32,821), *Journal of Neurochemistry* (13,374), *Journal of Comparative Neurology* (12,146), *Journal of Neurophysiology* (7652), *Neurology* (7113), and *Archives of Neurology* (5720). These six jour-

nals alone account for about 28% of the articles published in 1980. Furthermore, as is characteristic, they account for about 50% of the citations received by the neuroscience core. I have called this the concentration effect (Garfield 1977d) to distinguish it from the related law of scattering enunciated by Bradford (Bradford 1950). Thus, in order to cover any field comprehensively, one must cover an even larger network of journals.

In Table 2, we have listed the 50 journals that were most cited *by* the core in 1980. They are ranked according to the number of citations they received from the neuroscience core. The table also shows how often each journal was cited by all *SCI* journals. The number of citations these journals made to themselves (self-citations), the number of source items they published in 1980, 1979, and 1978, and their impact factors and immediacy indexes, which are measures of how often and quickly they are cited, are also shown. The 50 journals on this list received 121,632 citations—74.2% of the citations given out by the neuroscience core in 1980. Twenty-one of these most-cited journals were themselves members of the core.

The 50 journals which *cited* the neuroscience core most often are listed in Table 3. They are ranked in order of the number of references they made to the core. Thirty-three of these 50 journals are members of the core, listed in Table 1. Although these 50 journals account for only 2.91% of the *journals* that cited the core in 1980, they are responsible for 54.1% of the *citations* made to the core that year. A Bradford distribution would probably reveal that hundreds of additional journals are responsible for the remaining 45.9%. Most of these would be other well-known biomedical journals as well as the more obscure neuroscience publications.

Comparing Tables 2 and 3, we find that 30 journals appear in both. Twenty of these are core journals. In fact, six core journals were among the top ten on both lists, indicating that these journals truly represent the 'heart' of the core of neuroscience journals. These journals are *Brain Research, Journal of Comparative Neurology, Journal of Neurochemistry, Journal of Neurophysiology, Neurology,* and *Experimental Neurology.* Similarly, two non-core journals—*Life Sciences* and *Journal of Physiology (London)*—were among the 20 that most cited, and were most cited by, the core. Twenty-one percent of the citations received by these journals in 1980 were from the neuroscience core. It is clear that although these journals are not primarily oriented to neuroscientists, their authors are highly influenced by, and exert a significant influence upon, neuroscience researchers.

The presence of 29 non-core journals on our list of journals most cited by the neuroscience core, and of 17 non-core journals on the list of journals that cited this core most often, is significant. It indicates that journals outside the neuroscience core cite, and are cited by, this core a great deal.

This interaction between neuroscience and non-neuroscience journals can largely be attributed to the fact that neuroscience is a highly interdisciplinary field, with journals publishing articles of interest to physiologists, biochemists, pharmacologists, anatomists, cell biologists, and endocrinologists, to name just a few of the disciplines represented in these journals. For example, an article on the cell biology of the nervous system may have wide application to the cell biology of other systems.

Similarly, the rapid development of molecular approaches to the study of neurological phenomena has increased the interaction between endocrinology and biochemistry. The research history of opiate receptor research is but one of many examples (Garfield 1981b). Another reason for this interaction between neuroscience and non-neuroscience journals is that neuroscience is one of the most rapidly developing fields of modern research, and is attracting researchers from many disciplines. This is reflected in the large membership of the Society for Neuroscience as well as in the appearance of such publications as *Trends in Neurosciences.*

Another revealing characteristic of neuroscience journals is the percentage of citations they receive and contribute to other neuroscience publications. By these standards, the journals we originally identified as core journals do prove to be closely related. In most cases, at least half of the citations made by these journals are to core neuroscience journals. Similarly, at least half of the citations received by the core are from other core neuroscience journals.

Two other important indicators of a journal's quality are its impact factor and immediacy index. The impact factor measures the number of times an average article in a particular journal is cited. The immediacy index tells us how often the average article published in a particular journal is cited in the *same year* it was published.

In the 1980 *JCR*, impact is calculated by dividing the number of 1980 citations to source items published in 1978 and 1979, by

Table 2: The 50 journals most cited by neuroscience core journals.

Name	A	B	C	D	E	F	G	H	I	J	K
*1. Brain Res.	18383	32821	5448	56.0	16.6	29.6	3.75	.50	1219	1053	1090
*2. J. Comp. Neurol.	7660	12146	2791	63.1	23.0	36.4	5.48	.54	274	236	260
*3. J. Neurochem.	6039	13374	1904	45.2	14.2	31.5	3.14	.58	471	442	444
4. J. Physiol. (London)	5950	28073	—	21.2	—	—	3.64	.47	438	435	432
5. Science	5109	62929	—	8.1	—	—	5.71	1.53	1023	1039	999
6. Nature	4692	92968	—	5.0	—	—	6.50	1.61	1502	1544	1706
*7. J. Neurophysiol.	4584	7652	1206	59.9	15.8	26.3	4.16	.91	184	110	111
*8. Neurology	3556	7113	575	50.0	8.1	16.2	3.20	.47	248	274	234
9. Proc. Nat. Acad. Sci. USA	3071	87459	—	3.5	—	—	8.77	—	—	1423	1358
*10. Exp. Neurol.	3070	5380	595	57.1	11.1	19.4	1.64	.26	231	230	263
11. Life Sci.	2838	13691	—	20.7	—	—	3.74	.39	658	591	636
*12. J. Neurosurg.	2805	5959	1136	47.1	19.1	40.5	1.75	.24	291	261	281
*13. Exp. Brain Res.	2765	4323	443	64.0	10.2	16.0	2.62	.36	176	186	136
*14. Arch. Neurol.	2762	5720	292	48.3	5.1	10.6	1.79	.20	230	196	173
15. J. Biol. Chem.	2761	113670	—	2.4	—	—	5.71	.93	1942	1953	1403
*16. Electroencephalogr. Clin. Neurophysiol.	2586	4586	956	56.4	20.8	37.0	1.59	.33	208	166	170
17. J. Pharmacol. Exp. Ther.	2391	17042	—	14.0	—	—	3.28	.37	419	343	358
*18. Brain	2251	4275	128	52.7	3.0	5.7	3.70	.64	33	41	35
19. Endocrinology	2019	24675	—	8.2	—	—	4.70	.66	610	505	545
20. Eur. J. Pharmacol.	2006	9010	—	22.3	—	—	3.48	.40	492	463	382
21. Lancet	1952	51436	—	3.8	—	—	8.70	3.29	595	640	683
*22. J. Neurol. Neurosurg. Psychiatry	1779	3779	250	47.1	6.6	14.1	1.41	.23	169	177	182
23. Acta Physiol. Scand.	1572	8508	—	18.5	—	—	1.91	.46	209	218	272
24. Am. J. Physiol.	1551	26953	—	5.8	—	—	2.79	.45	876	757	724
25. Brit. J. Pharmacol.	1456	11097	—	13.1	—	—	4.53	.70	322	221	220
26. J. Cell Biol.	1441	27378	—	5.3	—	—	9.74	1.29	345	254	278
*27. Neurosci. Lett.	1435	2572	167	55.8	6.5	11.6	2.56	.32	306	302	238
*28. J. Neurol. Sci.	1304	2473	216	52.7	8.7	16.6	1.85	.19	168	132	142
29. Biochim. Biophys. Acta	1300	67641	—	1.9	—	—	2.86	.40	2205	2078	2132
*30. Neuropharmacology	1295	3182	235	40.7	7.4	18.1	3.00	.43	207	163	171
31. New Engl. J. Med.	1207	45790	—	2.6	—	—	14.21	2.60	360	362	363
32. Physiol. Behav.	1197	4668	—	25.6	—	—	1.23	.23	359	390	308
33. Biochem. Pharmacol.	1181	12628	—	9.4	—	—	2.45	.33	587	620	532
*34. J. Neuropathol. Exp. Neurol.	1153	2228	113	51.8	5.1	9.8	2.86	.35	49	46	48
*35. Acta Neuropathol.	1106	2149	302	51.5	14.1	27.3	1.28	.18	150	152	162
36. Fed. Proc.	1091	16403	—	6.7	—	—	0.38	.09	8350	6829	7239
*37. Neuroscience	1060	2131	287	49.7	13.5	27.1	4.16	.68	190	158	110
*38. Psychopharmacology	962	6436	368	14.9	5.7	38.3	1.82	.21	279	369	231
39. Biochem. J.	960	36945	—	2.6	—	—	3.20	.72	873	800	867
40. J. Comp. Physiol. Psychol.	956	4864	—	19.7	—	—	2.30	.54	103	97	107
41. Anat. Rec.	928	5871	—	15.8	—	—	3.32	.39	98	122	115
42. Ann. NY Acad. Sci.	907	17259	—	5.3	—	—	1.40	.49	258	592	414
43. Brit. Med. J.	882	27126	—	3.3	—	—	2.97	2.52	814	744	901
44. Naunyn-Schmiedebergs Arch. Pharmacol.	861	5969	—	14.4	—	—	3.67	.51	183	189	187
45. J. Anat.	850	3511	—	24.2	—	—	1.30	.20	126	135	149
*46. Ann. Neurol.	817	1599	171	51.1	10.7	20.9	2.43	.41	200	210	208
47. Pharmacol. Biochem. Behav.	806	2729	—	29.5	—	—	1.89	.19	353	290	276
48. Neur. Abstr.	804	1535	—	52.4	—	—	—	—	—	—	—
*49. Epilepsia	774	1375	189	56.3	13.7	24.4	1.70	.26	70	74	61
50. J. Histochem. Cytochem.	746	7196	—	10.4	—	—	2.56	.60	176	286	129

*Indicates a core member.
A = citations received from neuroscience journals.
B = citations received from all journals.
C = self-citations.
D = % of total citations that are core citations (A/B).
E = % of total citations that are self-citations (C/B).
F = % of core citations that are self-citations (C/A).
G = impact factor.
H = immediacy index.
I = 1980 source items.
J = 1979 source items.
K = 1978 source items.

Table 3: The 50 journals which most frequently cited neuroscience core journals.

Name	A	B	C	D	E	F	G	H	I	J	K
*1. Brain Res.	12837	32404	5448	39.6	16.8	42.4	3.75	.50	1219	1053	1090
*2. J. Comp. Neurol.	6731	13019	2791	51.7	21.3	41.5	5.48	.54	274	236	260
*3. J. Neurochem.	3799	12973	1904	29.3	14.7	50.1	3.14	.58	271	442	444
*4. J. Neurophysiol.	3466	7618	1206	45.5	15.8	34.8	4.16	.91	184	110	111
*5. Neuroscience	3009	7799	287	38.6	3.7	9.5	4.16	.68	190	158	110
*6. Brain Res. Bull.	2912	9019	97	32.3	1.1	3.3	1.30	.11	311	141	109
*7. Exp. Neurol.	2848	6452	595	44.1	9.2	20.9	1.64	.26	231	230	263
*8. Exp. Brain Res.	2671	5380	443	49.6	8.2	16.6	2.62	.36	176	186	136
*9. J. Neurosurg.	2326	6132	1136	37.9	18.5	48.8	1.75	.24	291	261	281
*10. Neurology	2279	5721	575	39.8	10.1	25.2	3.20	.47	248	274	234
*11. Electroencephalogr. Clin. Neurophysiol.	2135	4617	956	46.2	20.7	44.8	1.59	.33	208	166	170
*12. Neurosci. Lett.	1971	4645	167	42.4	3.6	8.5	2.56	.32	306	302	238
13. Life Sci.	1939	16023	—	12.1	—	—	3.74	.39	658	591	636
*14. Ann. Neurol.	1877	4537	171	41.4	3.8	9.1	2.43	.41	200	210	208
15. J. Physiol. (London)	1806	13586	—	13.3	—	—	3.64	.47	438	435	432
16. Pharmacol. Biochem. Behav.	1756	9436	—	18.6	—	—	1.89	.19	353	290	276
*17. Arch. Neurol.	1669	4229	292	39.5	6.9	17.5	1.79	.20	230	196	173
*18. Adv. Neurol.	1668	4788	27	34.8	6.6	1.6	.63	.00	82	199	133
*19. J. Neurol. Sci.	1491	4075	216	36.6	5.3	14.5	1.85	.19	168	132	142
*20. Adv. Biochem. Psychopharmacol.	1470	7835	63	18.8	.8	4.3	3.02	.07	301	42	68
*21. Prog. Neurobiol.	1405	3779	16	37.2	.4	1.1	5.67	.11	18	15	15
*22. J. Neurol. Neurosurg. Psychiatry	1369	3953	250	34.6	6.3	18.3	1.41	.23	169	177	182
*23. Psychopharmacology	1365	6436	317	21.2	4.9	23.2	1.82	.21	279	369	231
24. Physiol. Behav.	1359	8509	—	16.0	—	—	1.23	.23	359	390	308
*25. Acta Neuropathol.	1250	3499	302	35.7	8.6	24.2	1.28	.18	150	152	162
26. Science	1237	26420	—	4.7	—	—	5.71	1.53	1023	1039	999
*27. Neuropharmacology	1218	4720	235	25.8	5.0	19.3	3.00	.43	207	163	171
*28. Zh. Nevropatol. Psikhiatr. Im. S.S. Korsakova	1176	6055	499	19.4	8.2	42.4	.25	.02	323	282	317
29. Surg. Neurol.	1174	3165	—	37.1	—	—	.18	.09	177	191	152
30. Physiol. Rev.	1143	8077	—	14.2	—	—	14.41	.61	23	21	18
31. Nature	1022	32689	—	3.1	—	—	6.50	1.61	1502	1544	1706
32. Eur. J. Pharmacol.	996	8881	—	11.2	—	—	3.48	.40	492	463	382
*33. Neurochem. Res.	960	2992	36	32.1	1.2	3.8	1.99	.19	109	71	60
34. Cell Tissue Res.	937	11600	—	8.1	—	—	1.80	.29	393	400	439
35. J. Pharmacol. Exp. Ther.	933	12593	—	7.4	—	—	3.28	.37	419	343	358
*36. Zh. Vyssh. Nervn. Deyat. Im. I.P. Pavlova	806	2857	386	28.2	13.5	47.9	.21	.05	187	186	181
37. Anat. Embryol.	786	2767	—	28.4	—	—	1.32	.20	89	76	74
*38. Acta Neurochir.	766	2121	94	36.1	4.4	12.3	.50	.05	118	147	157
*39. Acta Neurobiol. Exp.	727	2104	115	34.6	5.5	15.8	.61	.27	59	45	34
40. Stroke	717	2681	—	26.7	—	—	2.69	.35	106	113	91
*41. Acta Neurol. Scand.	711	1936	129	36.7	6.7	18.1	1.67	.17	94	86	111
*42. Nervenarzt	701	3175	136	22.1	4.3	19.4	.48	.16	112	127	113
*43. Neuroendocrinology	697	3803	223	18.3	5.9	32.0	2.63	.47	131	105	91
*44. Brain	696	1675	128	41.6	7.6	18.4	3.70	.64	33	41	35
45. Brain Lang.	678	2335	—	29.0	—	—	1.28	.21	89	57	61
*46. Epilepsia	667	1717	189	38.8	11.0	28.3	1.70	.26	70	74	61
*47. Can. J. Neurol. Sci.	658	1566	149	42.0	9.5	22.6	1.75	.14	74	65	69
48. Proc. Nat. Acad. Sci. USA	645	40446	—	1.6	—	—	8.77	—	—	1423	1358
49. Endocrinology	628	17772	—	3.5	—	—	4.70	.66	610	505	545
50. Adv. Cell Neurobiol.	624	1759	—	35.5	—	—	—	.42	—	—	—

*Indicates a core member.
A = total citations to the neuroscience core journals.
B = total citations to all journals.
C = self-citations.
D = % of total citations that are core citations (A/B).
E = % of total citations that are self-citations (C/B).
F = % of core citations that are self-citations (C/A).
G = impact factor.
H = immediacy index.
I = 1980 source items.
J = 1979 source items.
K = 1978 source items.

Table 4: The neuroscience core journals ranked by impact factor.

Impact factor	Journal
5.67	Progress in Neurobiology
5.48	Journal of Comparative Neurology
4.16	Journal of Neurophysiology
4.16	Neuroscience
3.75	Brain Research
3.70	Brain
3.20	Neurology
3.14	Journal of Neurochemistry
3.02	Advances in Biochemical Psychopharmacology
3.00	Journal of Neurocytology
3.00	Neuropharmacology
2.86	Journal of Neuropathology and Experimental Neurology
2.67	Neuroscience and Biobehavioral Reviews
2.63	Neuroendocrinology
2.62	Experimental Brain Research
2.56	Neuroscience Letters
2.55	Reviews of Neuroscience
2.43	Annals of Neurology
2.22	Journal of Neurobiology
2.02	Developmental Neuroscience
2.00	Hearing Research

Table 5: The neuroscience core journals ranked by immediacy index.

Immediacy index	Journal
.91	Journal of Neurophysiology
.75	Progress in Brain Research
.68	Neuroscience
.66	Hearing Research
.64	Brain
.58	Journal of Neurochemistry
.54	Journal of Comparative Neurology
.53	Journal of Neurocytology
.52	Journal of Neurobiology
.50	Brain Research
.47	Neuroendocrinology
.47	Neurology
.47	Neuropsychobiology
.46	Muscle & Nerve
.44	Brain, Behavior and Evolution
.43	Neuropharmacology
.41	Annals of Neurology
.39	Neuroscience and Biobehavioral Reviews
.36	Experimental Brain Research
.36	Psychoneuroendocrinology
.35	Journal of Neuropathology and Experimental Neurology
.33	Electroencephalography and Clinical Neurophysiology—EEG Journal
.32	Developmental Neuroscience
.32	Neuroscience Letters
.30	Applied Neurophysiology

the number of source items published in 1978 and 1979. The average impact factor for the core journals was 1.42. Consider that only 1018 journals in th . *JCR* had an impact higher than 1.00 in 1980. This higher than average impact is due in part to the high average number of references per neuroscience article mentioned earlier. It is precisely for this reason that journal impacts must be compared within disciplines. The 21 journals with impact factors of 2 or greater are listed in Table 4. Only 406 journals in the entire 1980 *SCI* had an impact greater than this.

Just how quickly a journal is cited can be determined by looking at the journal's immediacy index. For the 1980 *JCR*, we divided the number of citations the journal received in 1980 by the number of source items it published that year. The average immediacy index for the core journals was much higher than that for the average journal in the 1980 *JCR*—two and a half times higher, in fact. The neuroscience core journals had an average immediacy index of .21, compared to .08 for the average journal in 1980. The 25 journals with an immediacy index of .3 or higher are listed in Table 5. In the entire *SCI* file, 621 journals had higher immediacy indexes.

One publication, the *Neurosciences Research Program Bulletin*, was eliminated from this list because each issue is essentially a single long review article, with a lengthy bibliography. Review articles tend to be more highly cited than most other documents and this, in turn, gives monographs such as *Neurosciences Research Program Bulletin* distorted impact factors and immediacy indexes. If we had left this monograph in Tables 4 and 5, it would have ranked first on both lists, with an impact factor of 10.22, and an immediacy index of 1.5.

Taking a look at these last two tables, it is notable that the journal with the highest impact factor, *Progress in Neurobiology*, is not among the top 20 journals that frequently cite, and are most cited by, the neuroscience core. In other words, although this review journal is not as highly cited as many of the other core journals, the average article it published in 1978 and 1979 was highly cited in 1980. Clearly, the way impact factors and immediacy indexes are calculated places an emphasis on those journals which are highly cited by current literature. As a result, looking at a journal's impact factor over many years, we can often spot journals that are becoming important to a given discipline.

Our immediacy index data confirm the importance of the *Journal of Neurophysiology*

Table 6: Partial list of journals cited by *Neurology* in 1980.

		Number of times *Neurology* cited papers published this year										
Cited journal name	**Total**	**1980**	**1979**	**1978**	**1977**	**1976**	**1975**	**1974**	**1973**	**1972**	**1971**	**Rest**
Neurology	575	44	125	105	53	48	32	17	12	20	10	109
Arch. Neurol.	279	4	24	27	19	18	21	22	25	17	17	85
Brain	186	0	4	11	7	5	5	13	10	11	7	113
Lancet	181	0	19	22	34	22	11	3	11	11	7	41
New Engl. J. Med.	167	2	8	18	34	19	14	16	9	12	9	26
J. Neurol. Neurosurg. Psychiatry	142	1	7	16	16	21	10	8	3	6	7	47
Brain Res.	113	3	11	15	21	13	12	9	11	6	7	5
Ann. Neurol.	105	3	34	37	29	0	0	0	0	0	0	2
J. Neurol. Sci.	101	0	17	10	11	12	6	2	6	9	6	22
Science	94	0	8	14	13	6	5	10	12	6	1	19
Electroencephalogr. Clin. Neurophysiol.	77	1	1	12	12	2	6	9	5	0	4	25
J. Neurochem.	77	1	3	17	12	10	11	2	8	0	2	11
Brit. Med. J.	68	0	2	7	3	3	5	5	2	5	4	32
Acta Neurol. Scand.	63	0	1	6	6	4	5	5	4	5	0	27
J. Am. Med. Assoc.	60	0	1	1	2	6	1	3	4	1	6	35

Table 7: Partial list of journals that cited *Neurology* in 1980.

		Number of times *Neurology* papers published in this year were cited in 1980										
Citing journal name	**Total**	**1980**	**1979**	**1978**	**1977**	**1976**	**1975**	**1974**	**1973**	**1972**	**1971**	**Rest**
Neurology	575	44	125	105	53	48	32	17	12	20	10	109
Arch. Neurol.	290	1	27	37	38	31	26	14	15	12	5	84
Ann. Neurol.	286	2	44	45	30	25	20	16	10	10	6	78
J. Neurol. Neurosurg. Psychiatry	213	1	14	26	31	26	13	16	9	5	8	64
J. Neurol. Sci.	187	1	21	16	17	16	17	12	16	3	5	63
J. Neurosurg.	144	0	4	9	10	13	10	6	3	10	4	75
Adv. Neurol.	132	0	3	8	16	9	14	12	6	5	11	48
Stroke	132	0	10	10	6	6	8	3	5	24	5	55
Acta Neurol. Scand.	113	2	14	10	13	20	6	4	7	6	2	29
Muscle Nerve	106	3	18	27	9	10	7	5	1	0	0	26
J. Neurol.	91	3	10	10	11	6	11	9	2	1	5	23
Electroencephalogr. Clin. Neurophysiol.	90	1	12	10	9	7	5	0	3	3	3	37
Can. J. Neurol. Sci.	85	7	19	13	11	6	2	4	3	1	2	17
Zh. Nevropatol. Psikhiatr. Im. S.S. Korsakova	85	0	6	10	11	11	5	4	1	6	0	31
Nervenarzt	77	0	6	12	4	11	5	2	4	4	3	26
Eur. Neurol.	68	0	7	4	8	9	3	0	1	0	3	33
Surg. Neurol.	67	0	2	6	3	5	4	1	3	3	2	38
Rev. Neurol.	65	1	3	5	9	5	9	4	2	1	0	26
Epilepsia	63	2	5	9	6	5	5	5	2	3	1	20
Brain Res. Bull.	62	2	9	16	3	16	1	5	3	0	1	6
Exp. Neurol.	60	0	4	3	4	7	7	10	4	2	2	17
Acta Neuropathol.	59	2	0	5	8	8	4	2	3	5	2	20
Lancet	55	5	11	11	3	3	3	2	1	2	1	13
Brain	54	0	5	7	4	3	4	5	4	5	1	16
New Engl. J. Med.	53	4	14	10	7	6	3	0	0	2	0	7
Acta Neurochir.	50	0	0	3	2	1	3	3	1	3	2	32
Prog. Cardiovasc. Dis.	50	0	2	2	3	2	0	2	0	4	1	34
Brain Lang.	49	0	7	8	7	3	4	0	7	0	1	12
Brain Res.	46	1	3	11	4	4	2	0	6	2	0	13
Radiology	45	0	2	3	3	2	2	5	2	2	2	22

to neuroscientists and neurologists. In addition to having the highest immediacy index on our list, it ranks among the ten journals that are most cited by, and most frequently cite, the neuroscience core. This journal is, obviously, cited very *quickly*, as well as very *often*.

We can now identify the 'most significant' neuroscience journals as those which ranked among the top 20 in terms of citations from the core (Table 2), citations to the core (Table 3), impact (Table 4), and immediacy (Table 5). They are *Brain Research*, *Journal of Comparative Neurology*, *Journal of Neurochemistry*, *Journal of Neurophysiology*, *Neurology*, and *Experimental Brain Research*.

As a group, these journals were cited by the core journals more often than by journals outside this core. *Experimental Brain Research* received 64% of its citations from the core, more than any other journal on this list. Only 16% of these citations were self-citations, that is, citations made by *Experimental Brain Research* papers to other papers published in the same journal. This is relatively low for a neuroscience journal. *Brain Research*, the most-cited journal on our list, received 29.6% of its core citations from other papers published in the same journal.

These six journals have cited non-core journals slightly more often than they cited core journals. However, they did cite the core more often than the other journals we have identified as being in the neuroscience core. The *Journal of Comparative Neurology* cited this core most often—51.7% of its citations were to the core. About 41% of these citations were to other articles published in earlier issues of the *Journal of Comparative Neurology*.

In closing, it is important to note that in this study, we deliberately avoided a study of 'neurology' journals in the traditional sense of that term. Were space available, we could have created a 'Macro' journal of neurology and the results would have been quite different. To illustrate this point, I have included a list of the journals most cited by *Neurology* (Table 6) and a list of the journals that, in turn, cited *Neurology* most often (Table 7). If we had adopted this more clinical interpretation of neurological science, we would have found more clinical journals in Tables 2 and 3.

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