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The 250 Most-Cited Primary Authors, 1961-1975. Part III. Each Author's Most-Cited Publication

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Previously we have listed the 250 most-cited primary authors. We have described how the names were selected.[1] And we have examined the correlation between citedness and other forms of science recognition such as the Nobel prize and membership in national academies of science.[2] In this essay, the last of three parts, we have listed each author's most-cited publication.

The list appears on pages 11-20. It contains the most-cited publication for which each author was primary author. Textbooks, manuals, reviews, and other items not considered reports of original research were excluded. About half of these publications have appeared in our previous lists of highly-cited items.

The total citation count for each item is based on *Science Citation Index*® (*SCI*®) data from 1961 to 1975, or from the year of publication if published after 1961. Since one of the 250 most-cited authors was omitted to symbolize the incompleteness of such lists, this list actually contains 249 items.

It is notable that the list contains several items which have been cited relatively few times. Every one of the 250 most-cited authors has been cited over 4,000 times. So some readers may wonder about the paper by R M Barrer, for example, which was cited "only" 46 times. Most of the authors on this list have produced not only high-quality work, but also a large quantity of it. Barrer has published over 300 papers! His most cited publication, a 1959 textbook in physical chemistry,[3] had been cited 319 times through 1975. But we have not listed textbooks.

Over four-fifths of these papers were written in the 1950s and 1960s. Four were published in the 1920s, 8 in the 1930s, 29 in the 1940s, 103 in the 1950s, 102 in the 1960s, and 2 in the 1970s. The oldest work on the list is Freud's, which was first published in 1915. The most recent item on the list is Allison's 1971 paper on functions of thymus-derived lymphocytes in relation to autoimmunity.

Thirteen of these 250 papers have been featured in Citation Classics, the weekly *Current Contents*® (*CC*®) series in which authors comment on their classic papers. For each Citation Classic we have indicated the *CC* issue number, date and page number in brackets after the item. Undoubtedly many more of these papers will appear as Citation Classics in the future.

Just 17 journals account for over half of the articles, and less than a hundred journals account for all the articles. The *Journal of the American Chemical Society* (*JACS*) accounts for 26—over 10% of the total. The *Journal of Biological Chemistry* accounts for 15, *Biochemical Journal* 11, *Physical Review* 10, and *Journal of Chemical Physics* 6. *Angewandte Chemie, Biochimica et Biophysica Acta, Journal of Cell Biology, Journal of Molecular Biology* and *Journal of Physiology* account for 4 items each.

Several of the articles are parts of a series. The citation counts include citations only to the part listed. For instance, Seyferth's article is the second of a 79-part series on halomethyl-metal compounds. The last part was published in 1976, after which Seyferth and his colleagues ended their research in this field.

I previously discussed the fact that several scientific fields are not represented by the 250 most-cited primary authors.[1] Since botany was among the unrepresented fields, some readers may be surprised to see that D I Arnon's paper was published in *Plant Physiology.* However, Dr. Arnon assures us that he is *not* a botanist; his field is biochemistry. He explains, "At the time this article was published, there were not many chemists or biochemists interested in chloroplasts. Therefore I didn't publish it in a biochemistry journal. Today I would just as soon put it in *Biochimica et Biophysica Acta,* for example."[4]

Of course, some of these authors are well known for publications which do not appear on this list. For example, P W Bridgman is well known for his writings on the philosophy of science, which include his books *The Way Things Are*[5] and *The Logic of Modern Physics.*[6]

This list contains 40 books and 209 journal articles. Where multiple editions of a book have been published, we counted the citations to *all* editions of the book, but listed the publication date of the earliest edition. However, G W Snedecor's 1937 book on statistical methods was substantially revised and coauthored with W G Cochran in the 1956 edition.[7] This was the most-cited edition, but the citation count includes citations to all editions.

Collecting citation data on books was a bit tricky for several reasons. First, citation practices concerning books are far from uniform. Second, many of the books which appear on this list are classics which have gone through several editions.

The difficulties can be illustrated by the case of Sigmund Freud. With 8,490 citations, he is still among the most-cited authors, even though he died in 1939. In 1957 the Hogarth Press collected Freud's complete works into a multi-volume *Standard Edition.* This is often cited simply as "*Standard Edition,*" "*S.E.,*" or

"*Standard Ed.*" Thus, it appears in the *SCI* in all three forms. In addition, citations to Freud's work sometimes refer to the original publications. After examining the citations to all of Freud's works, it became apparent that Volume 14, concerning the history of the psychoanalytic movement, is the most-cited volume. The most-cited papers in this volume are "Instincts and their Vicissitudes," "Repression," "The Unconscious," "A Metapsychological Supplement to the Theory of Dreams," "Mourning and Melancholia," "A Case of Paranoia Running Counter to the Psycho-Analytic Theory of the Disease," "Thoughts for the Times on War and Death," and "On Transience," all written between 1915 and 1917. To simplify matters, we have listed the entire Volume 14 as Freud's most-cited work, even though he never published it as such.

Four hundred and thirty-three different authors wrote these 250 works! Eight authors are on the list both as primary and as co-authors: M Gell-Mann, C Djerassi, J Monod, L A Carlson, L D Landau, G E Palade, D H Spackman, and S Weinberg.

More than half (132) of the listed publications have only one author; 71, two authors; 29, three authors; 10, four authors; and 4, five authors. One paper has six, and two have seven authors.

During the past quarter-century the proportion of scientific papers having more than one author has increased significantly. Instead of working alone, as most did before World War II, many of our best scientists now work in teams.

As Derek J. De Solla Price of Yale University has reported, "Surprisingly enough, a detailed examination of the incidence of collaborative work in science shows that this is a phenomenon which has been increasing steadily and ever more rapidly since the beginning of the century.... Since that time the proportion of multi-author papers has acclerated steadily and powerfully, and it is now so large that if it continues at the present rate, by 1980 the single-author paper will be extinct."[8]

Price and others have suggested that the proportion of collaborative authorship in a field is related to the amount of economic support it receives. Price comments that "the amount of collaborative authorship measures no more than the economic value accorded to each field by society. A soft subject highly subsidized would become as collaborative as high energy physics...."[9] A recent study by Henry J. Petroski of the Argonne National Laboratory supports Price's conclusions.[10]

Although there is general consensus that collaboration is increasing, there is little agreement on how collaboration affects citation analysis. Some researchers claim that the effects are negligible, while others state that they are "intolerable."[11]

In *Social Stratification in Science*, Jonathan and Stephen Cole studied a wide range of citation data on 120 physicists. They found that, "The correlation between a straight citation count and total citations (including citations to collaborative work on which the physicist was not first author) is .96." The Coles suggest that "the omission of collaborative citations to papers on which the author was not first among collaborators does not affect substantive conclusions."[12] But this depends upon what phenomenon you are studying.

In a recent study, Duncan Lindsey of Cornell University and George Warren Brown of Washington University reached an opposite conclusion. They argued that "one of the more serious errors in empirical judgment made in the field of the sociology of science has been to measure both publications and citations with counting procedures that do not take into account multiple authorship." They explore several alternatives to the first-author dilemma, including a variety of weighting schemes such as awarding the first author of a two-author paper two-thirds credit, and the second author, one-third. However, they conclude, "Until it becomes possible to decompose the relative contribution of collaborators, it will be necessary to simply divide by the number of contributors and allocate the credit equally."[11]

Lindsey and Brown also used the *SCI* and *Social Sciences Citation Index*™ (*SSCI*™) to determine the proportion of collaborative papers in a variety of fields. Their results indicate wide variations from one field to another. For biochemistry, they found that 19% of the 155 papers sampled had one author; 46%, two; 22%, three; and 13%, four or more. For psychology (205 papers), the breakdown was 75%, one author; 21%, two; 3%, three; and only 1%, four or more. In economics, 83% of the 154 papers sampled had one author; 16%, two; 1%, three; and none had four.

In the past, there were two primary reasons for ISI® to largely ignore the first-author problem in various citation analyses. First, many of the most-cited authors did their important work in the first half of this century, when collaboration was less pervasive than at present. Second, many authors who did publish as part of a team also published many papers alone. Their "wrap-up" papers tended to be cited by others in the same way that review papers are now sometimes cited: as surrogates for groups of papers that characterize a particular research front.

The first-author "problem" in citation analysis is partly an artifact of the way *SCI* data is listed. To print the names of *all* authors of cited items would more than double the size of the *SCI—without significantly increasing its value for information retrieval.* But the data on co-authors is not lost, either in our printed indexes or on our tapes. We list only first authors in the citation indexes. But in the source indexes we include all co-authors of each item, as well as a full bibliographic description. Thus we have been able to use our own source data tapes from earlier years, in combination with citation data tapes, to compile all-author citation counts for over 4½ million source articles indexed in the *SCI* from 1961 to 1976.

This new data, which we are just now beginning to study, classifies authors in six ways. It lists authors by overall rank, by primary-author rank, by secondary-author rank, and alphabetically. A "residue" author ranking includes citations to books and journal articles published before 1961. And an alphabetic listing is provided for the "residue" authors.

There are several important differences between our new all-author data and the data which we have used in the past. First, of course, is the fact that the all-author data credits citations equally to all co-authors of a given publication, not just the first author. However, it was not feasible for us to obtain and process the names of all co-authors of material published before 1961. Citations to this material are included in the "residue" listing. Thus, for example, since Lowry's classic paper was published in 1951, his name appears only in the "residue" listing. The same is true for many Nobel laureates and other eminent scientists whose significant work was done in the forties and the fifties.

One advantage of the all-author data is that it will enable us to account for self-citations that previously were difficult to detect. Through a pattern of self-citation, one large research group could build up substantial citation counts based on its own local invisible college. It would be convenient to sociologists if such groups took on pseudonyms like the famous "mathematician" Bourbaki (actually a group), who appears in this list. But the in-breeding that takes place in science is often difficult to define. When can we say that a particular scientist has severed himself from his "family" and established a truly new group? And how can we determine the true extent to which particular scientists have made an impact on families of "offspring" scientists working both at the "birthplace" and elsewhere? The all-author data can simplify finding answers to such questions.

What is the effect of using all-author data to compile a list of most-cited authors? Since this list is based only on primary-author data, we might expect some significant changes when all-author data is used. In fact, when we compared these 250 authors with the 250 most-cited authors (overall) based on all-author data, only 69 names—28% of the total—were the same.

To conclude this series of editorials, let me remind you that our list of 250 most-cited primary authors cannot be perfect or complete. The omission of one author's name has symbolized this lack of completeness. But what is most important about this list is that we have not had to be familiar with the work of all the authors involved in order to select them. We have not had to read the authors' works or consult with their peers. Yet we have been able to produce a list of individuals who comprise a distinguished elite among scientists.

I am well aware of the possible failure of citation analysis in some cases, particularly in those of less-cited individuals. It is much easier to quarrel with the "evaluation" of a poorly-cited individual than to deny the reality of high citation impact.

Of the one million or more authors who have published between 1961 and 1975, we have looked at the top two-and-a-half hundredths of one percent. Considering the elaborate apparatus, such as peer review, needed to make selections for grants, honors, and even employment and tenure, I think the method we have used to construct this list deserves further consideration and refinement.

Basically, I regard myself as an apolitical person. But life is politics in one form or another, and politics in science—as in other walks of life—has its own peculiar set of injustices. Is there any way to minimize these injustices? The mechanisms by which scientific recognition is achieved are certainly political. But so long as ability, insight, talent, and genius are unevenly distributed among scientists, we should try to insure that the political system of science which grants recognition is as fair and as democratic as possible. I believe that citation analysis can further that objective.

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Figure 1. Each primary author's most-cited publication. Names of the 250 most-cited primary authors, 1961-1975, appear in boldface. The listed publication is the most-cited report of original research for which the author was primary author. Total citation count based on *Science Citation Index®* data.

	Total Citations 1961-1975	Primary Author's Most-Cited Publication
1.	422	**Abragam A.** *The principles of nuclear magnetism.* New York: Oxford, 1961. 599 pp.
2.	5,241	**Abramowitz M** & Stegun I. *Handbook of mathematical functions with formulas, graphs & mathematical tables.* New York: Dover, 1964. 1046 pp.
3.	851	**Abrikosov A A.** On the magnetic properties of superconductors of the second type. *Zh. Eksp. Teo.* 32:1442-52, 1952. (*Sov. Phys. JETP* 5:1174-82, 1957.)
4.	201	**Albert A,** Goldacre R & Phillips J. The strength of heterocyclic bases. *J. Chem. Soc.* p. 2240-9, 1948.
5.	167	**Allinger N L,** Hirsch J A, Miller M A, Tyminski I J & Van-Catledge F A. Conformational analysis. Part 60. Improved calculations of the structures and energies of hydrocarbons by the Westheimer method. *J. Am. Chem. S.* 1199-1210, 1968.
6.	194	**Allison A C,** Denman A M & Barnes R D. Cooperating and controlling functions of thymus-derived lymphocytes in relation to autoimmunity. *Lancet* 2:135-40, 1971.
7.	409	**Anden N E,** Dahlstrom A, Fuxe K, Larsson K, Olson L & Ungerstedt U. Ascending monoamine neurons to the telencephalon and diencephalon. *Acta. Physl. S.* 67:313-26, 1966.
8.	769	**Anderson P W.** Localized magnetic states in metals. *Phys. Rev.* 124:41-53, 1961.
9.	2,080	**Andrews P.** Estimation of the molecular weights of protein in Sephadexgel-filtration. *Biochem. J.* 91:222-33, 1964.
10.	1,806	**Arnon D I.** Copper enzymes in isolated chloroplasts; polyphenoloxidase in *Beta Vulgaris. Plant Physl.* 24:1-15, 1949.
11.	408	**Axelrod J** & Tomchick R. Enzymatic O-methylation of epinephrine and other catechols. *J. Biol. Chem.* 233:702-5, 1958.
12.	135	**Baker B R.** *Design of active-site-directed irreversible enzyme inhibitors; the organic chemistry of the enzymic active-size.* New York: Wiley, 1967. 325 pp.
13.	1,662	**Bardeen J,** Cooper, L N & Scheiffer J R. Theory of superconductivity. *Phys. Rev.* 108:1175-1204, 1957.
14.	46	**Barrer R M,** Baynham J W, Bultitude F W & Meier W M. Hydrothermal chemistry of the silicates. Part 8. Low temperature crystal growth of aluminosilicates, and some gallium and germanium analogues. *J. Chem. Soc.* p. 195-208, 1959.
15.	184	**Bartlett P D** & Hiatt R R. A series of tertiary butyl peresters showing concerted decomposition. *J. Am. Chem. S.* 80:1398-1405, 1958.
16.	267	**Barton D H R.** The stereochemistry of cyclohexane derivatives. *J. Chem. Soc.* p. 1027-40, 1953.
17.	88	**Basolo F** & Pearson R G. The transeffect in metal complexes. *Prog. Inorg. Chem.* 4:381-453, 1962.
18.	101	**Basov N G,** Grasyuk A Z, Zubarey I G, Katulin V N & Krokhin O N. Semiconductor quantum generator with two photon optical excitation. *Zh. Eksp. Teo.* 50:551-9, 1966. (*Sov. Phys. JETP* 23:366-71, 1966.)
19.	416	**Bates D R** & Damgaard A. The calculation of the absolute strengths of spectral lines. *Phi. T. Roy. A.* 242:101-22, 1949.
20.	104	**Bell R P** & Goodall D M. Kinetic hydrogen isotope effects in the ionization of some nitroparaffins. *P. Roy. Soc. A.* 294:273-97, 1966.
21.	7,300	**Bellamy L J.** *The infra-red spectra of complex molecules.* New York: Wiley, 1954. 323 pp.
22.	266	**Bellman R E.** *Introduction to matrix analysis.* New York: McGraw, 1960. 328 pp.
23.	451	**Bender M L.** Mechanism of catalysis of nucleophilic reactions of carboxylic acid derivatives. *Chem. Rev.* 60:53-113, 1960.
24.	228	**Benson S W.** Bond energies. *J. Chem. Educ.* 42:502-18, 1965.

Total Citations 1961-1975		Primary Author's Most-Cited Publication
25.	414	**Bergstrom S**, Carlson L A & Weeks J R. The prostaglandins: a family of biologically active lipids. *Pharm. Rev.* 20:1-48, 1968.
26.	518	**Berson S A**, Yalow R S, Bauman M, Rothschild A & Newerly K. Insulin-I^{131} metabolism in human subjects: demonstration of insulin binding globulin in the circulation of insulin treated subjects. *J. Clin. Inv.* 35:170-90, 1956.
27.	545	**Bethe H A**. Zur theorie des durchgangs schneller korpuskularstrahlen durch materie. (On the theory of the passage of corpuscular rays through matter). *Ann. Physik* 5:325-400, 1930.
28.	356	**Beutler E**. The glutathione instability of drug-sensitive red cells. *J. La. Cl. Med.* 49:84-95, 1957
29.	443	**Billingham R E** & Medawar P B. The technique of free skin grafting in mammals. *J. Exp. Biol.* 28:385-402, 1951.
30.	132	**Birch A J**. The reduction of organic compounds by metal-ammonia solutions. *Q. Rev. Chem. Soc.* 4:69-93, 1950.
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34.	476	**Bourbaki N**. *Algèbre commutative.* Paris: Hermann, 1961. (*Commutative algebra.* Reading, MA: Addison-Wesley, 1972. 625 pp.)
35.	1,203	**Boyer P D**. Spectrophotometric study of the reaction of protein sulfhydryl groups with organic mercurials. *J. Am. Chem. S.* 76:4331-7, 1954.
36.	130	**Brachet J**, Denis H & DeVitry F. The effects of antimonycin D and puromycin on morphogenesis in amphibian eggs and *Acetabularia mediterranea. Develop. Bio.* 9:398-434, 1964.
37.	168	**Braunwald E** & Frahm C J. Studies on Starling's law of the heart. *Circulation* 24:633-42, 1961.
38.	6,952	**Bray G A**. A simple efficient liquid scintillator for counting aqueous solutions in a liquid scintillation counter. *Analyt. Bioc.* 1:279-85, 1960. [Citation Classics. *Current Contents* No. 2, 10 Jan 1977, p. 16.]
39.	126	**Bridgman P W**. The compression of 39 substances to 100,000 KG/CM. *P. Am. Acad. Art Sci.* 76:55-70, 1948.
40.	328	**Brodie B B**, Gillette, J R & LaDu B N. Enzymatic metabolism of drugs and other foreign compounds. *Ann. R. Bioch.* 27:427-54, 1958.
41.	544	**Brown H C** & Okamoto Y. Directive effects in aromatic substitution. Part 30. Electrophilic substituent constants. *J. Am. Chem. S.* 80:4979-87, 1958.
42.	918	**Brown J B**. A chemical method for the determination of oestriol, oestrone, and oestradiol in human urine. *Biochem. J.* 60:185-93, 1955.
43.	508	**Buckingham A D**. Chemical shifts in the magnetic resonance spectra of molecules containing polar groups. *Can. J. Chem.* 38:300-7, 1960.
44.	275	**Budzikiewicz H**, Wilson J M & Djerassi C. Mass spectrometry in structural and stereochemical problems. Part 32. Pentacyclic triterpenes. *J. Am. Chem. S.* 85:3688-99, 1963.
45.	315	**Bunnett J F**. Kinetics of reactions in moderately concentrated aqueous acids. I. Classification of reactions. *J. Am. Chem. S.* 83:4956-67, 1961.
46.	811	**Burn J H** & Rand M J. The action of sympathomimetic amines in animals treated with reserpine. *J. Physl. Lon.* 144:314-36, 1958.
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50.	349	**Carlson L A** & Waldeck S. Determination of serum triglycerides. *J. Atheroscl.* 3:334-6, 1963.
51.	506	**Carlsson A.** A fluorimetric method for the determination of dopamine (3-hydroxytyramine). *Acta. Physl. S.* 44:293-8, 1958.
52.	65	**Cattell R B.** The Scree test for the number of factors. *Mult. Behav. Res.* 1:245-76, 1966.
53.	870	**Chance B** & Williams G R. The respiratory chain and oxidative phosphorylation. *Adv. Enzymol.* 17:65-134, 1956.
54.	876	**Chandrasekhar S.** Stochastic problems in physics and astronomy. *Rev. M. Phys.* 15:1-89, 1943.
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66.	1,780	**Cromer D T** & Waber J T. Scattering factors computed from relativistic Dirac-Slater wave functions. *Act. Cryst.* 18:104-9, 1965.
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68.	709	**Cuatrecasas P.** Protein purification by affinity chromatography; derivations of agarose and polyacrylamide beads. *J. Biol. Chem.* 245:3059-65, 1970.
69.	215	**Curtis D R** & Watkins J C. The excitation and depression of spinal neurones by structurally related amino acids. *J. Neurochem.* 6:117-41, 1960.
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