

The 250 Most-Cited Primary Authors, 1961-1975.
Part II. The Correlation Between Citedness,
Nobel Prizes, and Academy Memberships

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The value of citation analysis for identifying important scientific work has been amply illustrated by the many studies we have reported on highly cited papers, journals, and authors. It is less well known that a high correlation exists between citedness and other forms of scientific recognition. The purpose of this essay is to document this correlation for the 250 most-cited primary authors. Last week we explained how the names were selected.¹ This week we've added data on the most visible forms of scientific recognition: the Nobel prize and membership in a national academy of science. Next week we'll provide the most-cited publication for each of these same 250 authors.

In Figure 1 on pages 7-9 we have listed the 250 most-cited primary authors. Actually there are only 249, since one name was omitted to symbolize the lack of precision in such compilations. Each author's total citation count from 1961 to 1975 is provided, as well as memberships in national academies of science. The names of Nobel prize winners are printed in bold-face type, followed by the year the prize was awarded and a code indicating the subject area.

Our rationale for including data only on Nobel prizes and memberships in national academies of science is simply that these are the two most significant and most visible indicators of scientific status. In one study, Jonathan and Stephen Cole asked 1,278 physicists in the United States to rate 98 honorific awards in terms of visibility and prestige. The Nobel prize ranked first, followed closely by membership in national academies of science. Taken together, the Nobel and academy membership "stand out above all the rest," the Coles said.² (p. 47)

Our list includes 42 Nobel prize winners: 15 in physiology or medicine, 14 in physics, and 13 in chemistry. Thus, 17% of the 250 most-cited authors are Nobel laureates.

Since 1901, when the first Nobel prize was awarded, 320 persons have become laureates in the sciences. These include 121 in physiology or medicine, 109 in physics, and 90 in chemistry. A single prize can be shared by more than one individual, and a single individual can win more than one prize. Thirteen percent of *all* Nobelists appear on our list.

What about the 278 Nobel prize winners who are *not* on this list of

250 most-cited authors? Many won their prizes for work done in the late nineteenth and early twentieth centuries. While the work of such early pioneers is still cited quite often, it is not surprising that the citation rate has fallen off after so many years. Of course, many more Nobel laureates will show up when we extend our list to include the 1,000 most-cited authors. This would include authors who had been cited about 2,000 or more times. If we extend the list to the 5,000 most-cited authors, it would include all but perhaps a few Nobelists. And even 5,000 authors represent less than 1% of all publishing scientists, past and present!

I believe it is axiomatic that not all the best qualified people have received the Nobel prize. There's no shortage of deserving people. We can be thankful for this. It would be terrible indeed if the prize fell into disrepute because of a shortage of first-rate scientists. That many deserving people, including most-cited scientists, have not won the prize does not indicate a deficiency in today's criteria for selecting winners; it simply indicates an abundance of first-rate candidates.

Certainly membership in a national academy of science is a less exclusive honor than the Nobel. Nevertheless, the number of memberships in each national academy is usually strictly limited. The United States National Academy of Science (NAS) had 1,182 members in 1976. The NAS admits up to 75 new members per year. Since there

were over 155,000 publishing scientists in the United States in 1976,³ Academy members comprised an elite 0.7% of all publishing American scientists.

National academies are well represented among these 250 most cited authors. One hundred and ten—44%—have been elected to the NAS. This accounts for about 9% of the total NAS membership. Fifty-five of the 250 authors belong to the Royal Society of London—about 6% of its total membership of 836. Seven authors belong to the 226-member French Academy of Sciences. Incidentally, the latter should not be confused with the 40-member French Academy.

Seven authors belong to the 766-member Soviet Academy of Sciences. Since our counts are based on 1961-1975 data, there *may* be some underrepresentation here due to less coverage of Soviet literature in the early days of the *SCI*[®].

Three authors belong to the 437-member Royal Society of Canada and 3 to the 276-member Royal Swedish Academy of Sciences. Thus, 151 of these 250 most cited authors—or over 60%—are members of at least one national academy.

There is a considerable amount of overlap between the Nobel prizes and memberships in national academies of science. Ninety-two percent of Nobel winners on the list are also members of their national academies. And over a quarter of the academy members on our list have won the Nobel prize.

Simply for lack of time and re-

Figure 1. Nobel Prizes and memberships in national academies of science among the 250 most-cited primary authors, 1961-1975. The selection of authors is based on data from the *Science Citation Index*[®]. Names of Nobel laureates appear in bold type, followed by year and category of prize; P = physics, C = chemistry, M = physiology or medicine. Correspondents, fellows, foreign members, and foreign associates are included as members of their respective national academies.

Name	Total Citations 1961-1975	National Academy	Name	Total Citations 1961-1975	National Academy
Abragam A	6,769	France	Brodie BB	7,493	U.S.
Abramowitz M	5,108		Brown HC	16,623	U.S.
Abrikosov AA	5,429	U.S.S.R.	Brown JB	4,074	
Albert A	8,664		Buckingham AD	4,332	U.K.
Allinger NL	4,140		Budzikiewicz H	5,089	
Allison AC	6,105		Bunnett JF	4,370	
Anden NE	5,147		Burn JH	5,650	U.K.
Anderson PW (77P)	6,787	U.S.	Burnet FM (60M)	5,553	U.K., U.S.
Andrews P	4,485		Burton K	6,913	U.K.
Arnon DI	4,323	U.S.	Busing WR	5,066	
Axelrod J (70M)	6,973	U.S.	Carlson LA	4,282	
Baker BR	5,395		Carlsson A	7,697	
Bardeen J (56P)	4,788	U.S., U.K.	Cattell RB	4,190	
(72P)			Chance B	16,306	U.S.
Barrer RM	5,230	U.K.	Chandrasekhar S	8,179	U.S., U.K.
Bartlett PD	5,180	U.S.	Chapman S	5,235	U.K., U.S.
Barton DHR (69C)	7,763	U.K., U.S.	Chatt J	6,692	U.K.
Basolo F	4,083		Clementi E	5,684	
Basov NG (64 P)	4,320	U.S.S.R.	Cohen MH	4,808	
Bates DR	6,925	U.K.	Conney AH	5,151	
Bell RP	4,400	U.K., U.S.	Cope AC	5,269	
Bellamy LJ	10,736		Corey EJ	9,901	U.S.
Bellman RE	5,678		Cotton FA	12,901	U.S.
Bender ML	4,924	U.S.	Coulson CA	6,569	U.K.
Benson SW	5,319		Courant R	4,154	
Bergstrom S	4,473	Sweden, U.S.	Cram DJ	6,148	U.S.
Berson SA	4,486		Cromer DT	5,418	
Bethe HA (67P)	7,718	U.S., U.K.	Cruickshank DWJ	4,512	
Beutler E	5,636	U.S.	Cuatrecasas P	4,484	
Billingham RE	6,269	U.K.	Curtis DR	4,794	
Birch AJ	4,339	U.K.	Dacie JV	4,323	U.K.
Bjorken JD	4,264	U.S.	Dalgarno A	5,365	U.K.
Bloembergen N	5,234	U.S.	Davis BJ	7,074	
Born M (54 P)	9,206	U.S.	Dawson RMC	4,125	
Bourbaki N	4,860		DeDuve C (74 M)	8,445	U.S., Belgium
Boyer PD	6,906	U.S.	DeRobertis E	4,801	
Brachet J	5,956	U.S., U.K.	Dewar MJS	9,800	U.K.
		France	Dische Z	7,874	U.S.
Braunwald E	4,980	U.S.	Dixon M	6,331	U.K.
Bray GA	8,012		Djerassi C	8,520	U.S.
Bridgman PW (46P)	5,053	U.S., U.K.	Doering WVE	4,253	U.S.

Figure 1. Nobel prizes and memberships in national academies of science among the 250 most-cited primary authors, 1961-1975 (continued).

Name	Total Citations 1961-1975	National Academy	Name	Total Citations 1961-1975	National Academy
Dole VP	5,902	U.S.	Hirs CHW	4,578	
Duncan DB	4,153		Hirschfelder JO	7,033	U.S.
Eagle H	6,498	U.S.	Hodgkin AL (63 M)	7,500	U.K., U.S.
Eccles J C (63M)	10,104	U.K., U.S.	Horner L	4,469	
Eigen M (67C)	4,980	U.K., U.S.	House HO	4,393	
Eliel EL	8,615	U.S.	Hubel DH	4,640	U.S.
Erdelyi A	5,978	U.K.	Huisgen R	9,309	F.R.G., G.D.R.
Eysenck HJ	5,241		Huxley HE	4,073	U.K.
Fahey JL	4,724		Ingold CK	4,198	
Falck B	4,275		Jackman LM	4,927	
Farquhar MG	4,525		Jacob F (65 M)	7,101	U.K. U.S., France
Fawcett DW	6,236	U.S.	Jaffé HH	5,106	
Feigl F	4,074		Johnson HL	4,117	U.S.
Feldberg W	4,762	U.K.	Jorgensen CK	6,049	Denmark
Feynman RP (65P)	6,031	U.S., U.K.	Kabat EA	7,529	U.S.
Fieser LF	9,392	U.S.	Karnovsky MJ	5,616	
Fischer EO (73C)	4,788		Karplus M	5,770	U.S.
Fisher ME	4,289	U.K.	Kato T	4,138	
Fisher RA	8,336	U.K.	Katritzky AR	4,704	
Fiske CH	8,249		Katz B (70 M)	4,690	U.K., U.S.
Flory PJ (74 C)	10,247	U.S.	Keilin D	4,121	
Folch J	9,693		Kety SS	4,594	U.S.
Fraenkel-Conrat H	4,376	U.S.	King RB	5,109	
Fredrickson DS	6,897	U.S.	Kirkwood JG	4,084	U.S.
Freud S	8,490	U.K.	Kittel C	5,591	U.S.
Friedel J	4,325	France	Klein G	4,430	U.S.
Gell-Mann M (69 P)	9,669	U.S.	Klotz IM	4,151	U.S.
Gilman H	7,849	U.S., U.K.	Kolthoff IM	9,697	U.S.
Ginzburg VL	6,834	U.S.S.R.	Kornberg A (59 M)	4,548	U.S., U.K.
Glasstone S	5,080		Krebs HA (53 M)	7,657	U.K., U.S.
Gomori G	7,136		Kubo R	4,232	U.S.
Good RA	4,607	U.S.	Kuhn R (38C)	7,488	
Goodman LS	5,627	U.S.	Landau LD (62 P)	18,888	U.S.S.R.
Goodwin TW	4,727	U.K.	Lee T D (57 P)	4,879	U.S.
Gornall AG	5,921	Canada	Lehninger AL	5,507	U.S.
Grabar P	4,717		Lemieux RU	4,619	Canada, U.K.
Granit RA (67 M)	4,629	U.K., U.S., Sweden	Levine S	4,035	
Green DE	4,708	U.S.	Lineweaver H	5,202	
Gutowky HS	4,286	U.S.	Löwdin PO	5,060	Sweden, Norway
Hansen M	5,262	U.S.	Lowry OH	58,304	U.S.
Harned HS	4,960	U.S.	Luft JH	8,926	
Herbert V	4,106		Marmur J	6,475	
Herzberg G (71 C)	13,110	U.S., U.K., Canada	McConnell HM	5,490	U.S.

Figure 1. Nobel prizes and memberships in national academies of science among the 250 most-cited primary authors, 1961-1975 (continued).

Name	Total Citations 1961-1975	National Academy	Name	Total Citations 1961-1975	National Academy
McKusick VA	4,181		Seitz F	5,396	U.S.
Miller JFA	6,371	U.K.	Selye H	8,928	Canada
Millonig G	4,106		Seyferth D	4,462	
Mitchell P	4,086	U.K.	Sillen LG	4,375	
Monod J (65 M)	4,791	U.S.	Skou JC	4,127	
Moore S (72 C)	8,167	U.S.	Slater JC	7,587	U.S.
Morse PM	5,089	U.S.	Smith HW	6,946	
Mott NF (77 P)	10,473	U.K., U.S.	Smithies O	6,192	U.S.
Muller A	4,500		Snedecor GW	14,762	
Müller E	4,664	U.S.	Somogyi M	4,465	
Mulliken RS (66 C)	10,508	U.S., U.K.	Spackman DH	6,889	
Nakamoto K	5,132		Spitzer L	4,238	U.S.
Natta G (63 C)	5,735	Italy, France, U.S.S.R.	Stahl E	6,252	
			Steel RGD	5,100	
Nesmeyanov AN	6,783	U.S.S.R., U.K.	Streitwieser A	7,511	U.S.
Newman MS	4,730	U.S.	Sutherland EW (71 M)	5,150	
Novikoff AB	7,662	U.S.	Taft RW	5,083	
Olah GA	8,311	U.S.	Tanford C	5,934	U.S.
Ouchterlony O	5,986		Udenfriend S	5,039	U.S.
Palade GE (74 M)	5,969		Umbreit WW	5,229	
Pallng L (54 C) (62 Peace)	15,662	U.S., France, U.K., U.S.S.R.	Van Slyke DD	4,282	
			Van Vleck JH (77 P)	5,449	U.S., U.K., France
Pearse AGE	10,522		von Euler US (70M)	8,728	U.S., U.K.
Perutz MF (62 C)	4,263	U.K., U.S., France	Walling C	5,590	U.S.
			Warburg O (31 M)	7,463	U.K.
Pople JA	15,135	U.K.	Warren L	4,303	
Prigogine I (77C)	4,681	U.S.	Watson ML	4,176	
Racker E	4,567	U.S.	Weber G	8,319	U.S.
Reed LJ	4,290	U.S.	Weber K	5,823	
Reynolds ES	10,115		Weinberg S	6,306	U.S.
Roberts JD	4,501	U.S.	Weiss P	4,048	U.S.
Robinson RA	5,543		Wiberg KB	5,461	U.S.
Rose ME	4,127		Wieland T	4,423	
Rossini FD	4,105	U.S.	Wigglesworth VB	4,489	U.K., U.S.
Russell GA	5,933		Wigner EP (63P)	4,948	U.S., U.K.
Sabatini DD	6,205		Wilson EB	5,139	U.S.
Scatchard G	4,191		Winer BJ	5,145	
Scheidegger JJ	4,159		Winstein S	7,884	
Schneider WC	7,029		Wittig G	6,079	France
Schwarzenbach G	4,618		Woodward RB (65 C)	7,069	U.S., U.K.
Schwinger J (65 P)	4,855	U.S.	Zachariasen WH	4,050	U.S.
Seeger A	4,757		Zeldovich YB	4,794	U.S.S.R.
			Ziman JM	4,499	U.K.
			Zimmerman HE	4,217	

sources we have not included information on other honors and awards. This does *not* mean that other prizes, awards or honors are less prestigious than the two we have discussed. There are numerous prizes, medals, awards, fellowships, and honors—some bestowed by local societies, some by national organizations, and some by international groups—which I believe are equally indicative of merit or impact. Since the prize is not awarded in such fields as engineering, mathematics, botany, and earth science, other awards are clearly *better* indicators of recognition in these fields than the Nobel prize.

The 250 listed authors have all made significant contributions to science. The citation record confirms this impact. Thus, almost all can be expected to have been recognized or honored in some way. For example, VL Ginzburg won the Lenin State Prize in Science and Technology as well as the Lomonosov Prize. RA Good received the Albert Lasker Medical Research Award. FA Cotton won the Leon H. Baekeland Award for industrial chemistry. EJ Corey has received numerous awards of the American Chemical Society. JA Pople received the American Chemical Society's Irving Langmuir Award in Chemical Physics. And EP Wigner, HA Bethe, F Seitz, B Chance, M Gell-Mann, and J Bardeen have all received the Franklin Institute's Gold Medal.

Since it is awarded only to Americans, we have not indicated which authors have received the National

Medal of Science (NMS). Awarded annually in the United States since 1962, the NMS recognizes work in the physical, mathematical, biological, and engineering sciences. As of 1975, 117 scientists had received it. Twenty-six, or 10.4%, of our 250 authors have won the NMS. These 26 include nine Nobelists and 22 NAS members. E Racker, M Cohen, HS Gutowsky, and FD Rossini were among the 15 NMS winners announced as this piece went to press.

The relationship between citedness and the NMS has also been investigated by Cole and Cole. Examining citations in only one year, 1965, they found that Nobel laureates from 1955 to 1965 averaged 199 citations, while winners of the National Medal of Science averaged 154.2 (p. 55) Both averages are, of course, very high.

The preceding discussion indicates that the 250 most-cited scientists are in turn highly recognized and honored. But are the most honored scientists also highly cited?

To answer this question we considered the citation records of all Nobel prize winners in science since 1950. The results are presented in Figure 2 on pages 12-13. Within the three subject area divisions the names of laureates are arranged chronologically by year of award. The laureate's name, country, and total citations from 1961 to 1975 are shown. The names of prize winners who also appear in Figure 1, the 250 most-cited primary authors, are in bold type.

Although the list of Nobel laureates contains 162 names, only 84

prizes in science have been awarded since 1950: one each year in physics, chemistry, and physiology or medicine. However, a single prize may be shared, as happened in 62% of the science prizes awarded since 1950. Thus, since 1950, 19 physics prizes, 11 chemistry prizes, and 22 physiology or medicine prizes have been shared.

The citation records of these 162 Nobelists range from a high of 18,888 for LD Landau to a low of 79 for JHD Jensen. Jensen, however, is an unusual case since he published only 14 papers, all in German, and all well before the advent of the *SCI* in 1961. In addition, according to EP Wigner, who shared the 1963 Nobel with Jensen and MG Mayer, ideas similar to Jensen's were proposed soon after his 1949 work on the structure of atomic nuclei, and Jensen's work may have been quickly "obliterated."⁴ Overall, the average number of citations received in the period 1961 to 1975 by these 162 Nobel laureates is 2,877; the median is 1,910. The average citation total for chemistry Nobelists is 3,507; for physiology or medicine 2,882; and for physics 2,424.

These averages are extremely high when compared to typical citation rates. According to *SCI* data the average cited author now receives about 8 citations per year.⁵ In the five years covered by the *SCI* cumulation for 1970-74, the average cited author received 16 citations.⁶ So over a 15-year period, the average cited author could be expected to accumulate less than 50 citations!

All Nobel laureates were cited more than this average rate. Thirty-eight laureates received between 100 and 999 citations; 34 from 1,000 to 1,999; 21 from 2,000 to 2,999; 16 from 3,000 to 3,999; and 43 Nobelists—27%—received over 4,000 citations in the 15-year period.

There are two reasons why some of these Nobelists may not have been cited enough to appear on our list. First, as has already been pointed out,¹ these citation counts are based on primary-author data. Thus, a citation to a co-authored paper was credited only to the first author. Consideration of the all-author data significantly improved the citation records of the Nobelists with fewest citations. For example, DA Glaser's citations jumped from 101 to 343; SCC Ting's went from 170 to 303; FC Robbins' count rose from 126 to 584; and AR Prokhorov's count increased from 146 to 1,031. It should be noted, however, that even some highly-cited Nobelists improve dramatically when all-author data is considered. For example, D Baltimore's count rose from 2,543 to 5,270; GM Edelman's from 3,414 to 6,797; and S Ochoa's from 2,425 to 4,172. In the near future we will publish a list of most-cited authors which is based on all-author data.

Some Nobelists have relatively low citation counts which are not appreciably improved by consideration of the all-author data. These include PA Cherenkov with only 84 citations, JD Crockcroft (93), EM McMillan (97), and ETS Walton (112). But each of these authors did

Figure 2. Nobel Prize winners since 1950 in physics, chemistry, and physiology or medicine. Total citations from 1961 to 1975 based on data from the *Science Citation Index*. Names in bold type also appear in Figure 1, the 250 most-cited primary authors, 1961-1975.

PHYSICS

Name	Country*	Total Citations 1961-1975	Name	Country*	Total Citations 1961-1975
1950 Powell C	Britain	247	1964 Prokhorov AM	U.S.S.R.	1,031
1951 Crockcroft JD	Britain	93	Townes CH	U.S.	2,570
Walton E	Ireland	112	1965 Feynman RP	U.S.	6,031
1952 Bloch F	U.S.	2,188	Schwinger JS	U.S.	4,855
Purcell EM	U.S.	577	Tomonaga S	Japan	236
1953 Zernike F	Netherlands	467	1966 Kastler A	France	570
1954 Born M	Germany	9,206	1967 Bethe HA	U.S.	7,718
Bothe W	Germany	201	1968 Alvarez LW	U.S.	331
1955 Kusch P	U.S.	459	1969 Gell-Mann M	U.S.	9,669
Lamb WE Jr.	U.S.	1,625	1970 Alfvén HOG	Sweden	1,909
1956 Bardeen J	U.S.	4,788	Neel LEF	France	3,070
Brattain W	U.S.	303	1971 Gabor D	Britain	1,749
Shockley W	U.S.	3,571	1972 Bardeen J	U.S.	4,788
1957 Lee TD	U.S.	4,879	Cooper LN	U.S.	323
Yang CN	U.S.	1,728	Schrieffer JR	U.S.	1,472
1958 Cherenkov PA	U.S.S.R.	84	1973 Esaki L	Japan	747
Frank IM	U.S.S.R.	274	Giaever I	U.S.	695
Tamm IY	U.S.S.R.	1,144	Josephson B	Britain	1,265
1959 Chamberlain O	U.S.	236	1974 Hewish A	Britain	766
Segrè E	U.S.	493	Ryle M	Britain	890
1960 Glaser D	U.S.	343	1975 Bohr AN	Denmark	3,517
1961 Hofstadter R	U.S.	1,686	Mottelson BR	Denmark	1,362
Mössbauer R	Germany	436	Rainwater J	U.S.	300
1962 Landau LD	U.S.S.R.	18,888	1976 Richter B	U.S.	205
1963 Jensen JHD	Germany	79	Ting SCC	U.S.	303
Mayer MG	U.S.	290	1977 Anderson PW	U.S.	6,787
Wigner EP	U.S.	4,948	Mott NF	Britain	10,473
1964 Basov NG	U.S.S.R.	4,320	Van Vleck JH	U.S.	5,449

CHEMISTRY

1950 Alder K	Germany	4,450	1959 Heyrovsky J	Czech	1,418
Diels O	Germany	1,372	1960 Libby WF	U.S.	832
1951 McMillan EM	U.S.	97	1961 Calvin M	U.S.	2,713
Seaborg G	U.S.	638	1962 Kendrew JC	Britain	1,654
1952 Martin AJP	Britain	777	Perutz MF	Britain	4,263
Synge R	Britain	417	1963 Natta G	Italy	5,735
1953 Staudinger H	Germany	3,325	Ziegler K	Germany	3,258
1954 Pauling LC	U.S.	15,662	1964 Hodgkin DMC	Britain	359
1955 Du Vigneaud V	U.S.	1,470	1965 Woodward RB	U.S.	7,069
1956 Hinshelwood C	Britain	476	1966 Mulliken RS	U.S.	10,508
Semenov N	U.S.S.R.	1,257	1967 Elgen M	Germany	4,980
1957 Todd A	Britain	275	Norrish RGW	Britain	980
1958 Sanger F	Britain	3,716	Porter G	Britain	3,202

CHEMISTRY (continued)

Name	Country*	Total Citations 1961-1975	Name	Country*	Total Citations 1961-1975
1968 Onsager L	U.S.	3,569	1973 Fischer E	Germany	4,788
1969 Barton DHR	Britain	8,135	Wilkinson G	Britain	967
Hassel O	Norway	1,113	1974 Flory PJ	U.S.	10,247
1970 Leloir LF	Argentina	2,221	1975 Cornforth JW	Australia	2,378
1971 Herzberg G	Canada	13,110	Prelog V	Switzerland	2,229
1972 Anfinson CB	U.S.	2,286	1976 Lipscomb WN	U.S.	1,443
Moore S	U.S.	8,167	1977 Prigogine I	Belgium	4,681
Stein WH	U.S.	1,274			

PHYSIOLOGY OR MEDICINE

1950 Hench PS	U.S.	316	1965 Monod J	France	4,791
Kendall EC	U.S.	179	1966 Huggins CB	U.S.	3,808
Reichstein T	Switzerland	1,178	Rous FP	U.S.	1,396
1951 Theiler M	South Africa	206	1967 Granit RA	Sweden	4,629
1952 Waksman SA	U.S.	2,291	Hartline HK	U.S.	1,183
1953 Lipmann FA	U.S.	2,038	Wald G	U.S.	3,002
Krebs HA	Britain	7,657	1968 Holley RW	U.S.	2,296
1954 Enders JF	U.S.	1,193	Khorana HG	U.S.	1,651
Robbins FC	U.S.	584	Nirenberg MW	U.S.	1,916
Weller TH	U.S.	1,972	1969 Delbruck M	U.S.	498
1955 Theorell AHT	Sweden	3,150	Hershey AD	U.S.	2,039
1956 Cournand AF	U.S.	1,263	Luria SE	U.S.	1,876
Forssmann W	Germany	637	1970 Axelrod J	U.S.	6,973
Richards D	U.S.	668	Katz B	Britain	4,690
1957 Bovet D	Italy	1,219	von Euler U	Sweden	8,728
1958 Beadle GW	U.S.	948	1971 Sutherland EW	U.S.	5,150
Lederberg J	U.S.	3,138	1972 Edelman GM	U.S.	3,414
Tatum EL	U.S.	285	Porter RR	Britain	2,528
1959 Kornberg A	U.S.	4,548	1973 von Frisch K	Germany	955
Ochoa S	U.S.	2,425	Lorenz KZ	Germany	1,560
1960 Burnet FM	Australia	5,553	Tinbergen N	Netherlands	1,205
Medawar PB	Britain	2,600	1974 DeDuke C	Belgium	8,445
1961 von Békésy G	U.S.	1,960	Claude A	U.S.	493
1962 Crick FHC	Britain	2,524	Palade GE	U.S.	5,969
Watson JD	U.S.	2,437	1975 Baltimore D	U.S.	2,543
Wilkins MHF	Britain	745	Dulbecco R	U.S.	4,005
1963 Eccles JC	Australia	10,104	Temin HM	U.S.	3,168
Hodgkin AL	Britain	7,500	1976 Blumberg BS	U.S.	3,555
Huxley AF	Britain	2,115	Gajdusek DC	U.S.	1,318
1964 Bloch K	U.S.	1,456	1977 Guillemin R	U.S.	2,395
Lynen F	Germany	3,020	Schally A	U.S.	2,985
1965 Jacob F	France	7,101	Yalow R	U.S.	3,658
Lwoff A	France	2,111			

* Citizenship of recipient at time of award.

their award-winning research well before the advent of the *Science Citation Index* in 1961.

For example, PA Cherenkov, born in 1904, discovered the "Cherenkov effect" in 1934 when he was still a student at the Institute of Physics of the USSR Academy of Sciences. In 1929, JD Cockroft, born in 1897, and ETS Walton, born in 1903, devised the accelerator that in 1931 disintegrated lithium nuclei with protons. And EM McMillan, born in 1907, isolated neptunium in 1940. Undoubtedly when we compile citation data for the pre-1961 years we will find this work heavily cited. I believe we will also observe that some of these discoveries were so profound in their impact and so quickly absorbed into the mainstream of science that they have since become obliterated.⁷

The fact is that virtually all Nobel prize winners are highly cited authors, especially in the years immediately preceding the award.⁸ In *The Scientific Elite*, Harriet Zuckerman reports that, "Each year before the award, between the years 1961-1971 prospective laureates are cited 222 times on the average. This is more than twice the average of 99 citations for a random sample of American scientists about to be elected to the National Academy of Sciences during the same years and almost 40 times the average of 6.1 citations to a representative author in the *SCI*."⁹ (p. 187-8).

The evidence for the correlation between citedness and Nobel awards has in fact been increasing. It is even possible to use citation

analysis to forecast Nobel prize winners. I demonstrated this in 1970, when I published a list of the 50 most-cited authors for 1967.¹⁰ Six of those 50 authors had won the Nobel previously, and *six more have won it since*. Since there have been about one million scientists who have published and could be cited, these results could hardly have been produced by a random selection.

The high citedness of Nobelists is, of course, due to the *amount* as well as the quality of the work they produce. Zuckerman found that "while still in their twenties they [Nobel laureates] published an average of 13.1 papers, strikingly more than the entire lifetime average of 3.5 pages that has been attributed to the general population of scientists."⁹ (p. 145) Sher and I obtained similar results in our 1965 study of Nobel prize winners.⁸

Just a few months ago, Cole and Cole, with Leonard Rubin, again demonstrated the strong relationship between citedness and other indicators of scientific status. Writing in *Scientific American*, they characterized 1,200 scientists according to nine variables, including a ranking of the graduate departments from which they received doctorates, current academic departments and ranks, age, published works, previous grants from the National Science Foundation, and citation records. They reported, "Our results show only weak or moderate correlations between each of the nine 'social stratification' variables and the ratings received on [NSF grant] proposals.... The most highly correlated variable was the number of

citations in the 1975 *Science Citation Index* of work published between 1965 and 1974."¹¹ Previously, Cole and Cole had asserted, "The data available indicate that straight citation counts are highly correlated with virtually every refined measure of quality."² (p. 35)

I and those who helped in preparing this study were as surprised as any other laymen at this year's choices for the Nobel prize. But you can well understand our sense of elation in observing that four of the seven science winners were among our most cited 250. These four were the physicists, PW Anderson, JH Van Vleck, and NF Mott, and the

chemist, I Prigogine. The other three, R Guillemin, R Yalow, and A Schally, actually were no surprise to us. Not only would they be among the 1,000 most-cited we could list, but their rankings in all-author data show them to be among the most-cited scientists of the past decade. Schally, who has co-authored over 430 papers, was cited over 10,000 times. Similarly, Yalow's work was cited over 5,500 times, and Guillemin's over 4,000 times.

In part three of this series I will discuss the all-author data in more detail and will list the most-cited publication of each of these 250 authors.

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