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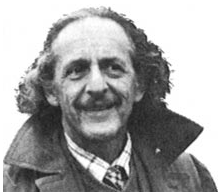

The Awards of Science: Beyond the Nobel Prize. Part 1. The Determinants of Prestige

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Some readers may believe there is a preoccupation in these pages with the Nobel prize. It is true that in our studies of most-cited authors, we have made a point of calling attention to those who have received the Nobel prize. And it is true that we have regularly examined the publication and citation records of recent Nobel prizewinners.[1-3] But we have also called attention to other forms of recognition, such as memberships in national academies.[4] And rather than regurgitate the topical write-ups on Nobel prizewinners that appear in the science and the popular press, we have tried to emphasize, in a more specific way, the particular publications for which those authors became recognized.

Thus, if we seem preoccupied with the Nobel prize and with the use of citation analysis to identify authors *of Nobel class*,[1] it is only because the Nobel prize has become the universal symbol of recognized excellence in science. In fact, the Nobel prize is unique among all awards in science in that it is as well known to the general public as it is to the scientific community.[5] Beyond the grasp of the vast majority of working scientists, the prizes are "noble" in the truest sense of the word: illustrious, or possessed of outstanding qualities. Therefore, if a case is going to be made that citation frequency is an *indicator* of excellence, using the most obvious examples of recognized excellence is a natural way to demonstrate that case. This demonstration, however, is not proof that citation frequency and eminence stand in perfect correlation. There may be eminent scientists who are not highly cited, since citation rates are specific to each field. In other words, a scientist in a "small" field may garner relatively few citations in absolute terms when compared to the citations a scientist in a "large" or "hot" field may acquire. Nevertheless, the scientist in the small field may well be highly cited in comparison to others in his or her field.

For all their overwhelming prestige, the Nobel prizes are merely the most visible among numerous other prestigious awards that recognize achievement by scientists. When I first thought about doing this essay, I referred to them facetiously as the "un-Nobel awards." Later this became the "non-Nobel awards." But that is not to say that they are *ignoble*, for they are by no means common or characterized by baseness. The proliferation of these para-Nobel awards reflects the exponential growth of science in the 80 years since the Nobel prize was established. Perhaps the primary message of my research has been that there just are not enough prizes to go around. This applies not only to individuals, but even to entire research fronts or specialties.

In this essay, we will call attention to the large number of awards that recognize excellence in science. A future essay will call attention to the most recent winners of the non-Nobel prizes. I do not think we should attempt

a ranking of these awards. To do so would be to invite debate over the criteria by which we had arrived at our judgments. At best, those criteria would necessarily involve some subjective factors. Naturally, this begs the question of whether or not the judgment of a particular award committee—even that of a Nobel committee—is necessarily better than that of some other committee. Of course, some argue that the Nobel selection procedure *does* ensure the best possible choices. However, the Nobel in its turn has been criticized for a certain lag in responsiveness. It may often come many years after others have recognized a breakthrough. For instance, 36 Lasker awardees later went on to win the Nobel prize.

The question of how a committee selects candidates and awards prizes raises other important considerations. For example, how many of the scholars listed in our study of the 1,000 contemporary scientists most cited between 1965 and 1978[6] are in fact eminent, in terms of awards that could be considered *of Nobel class*? Another equally relevant question is, how many of the 1,000 authors have *not* been recognized by awards? And of these, how many deserve recognition? Finally, and most important, how many names appear on the list by virtue of the peculiarities of citation behavior, rather than the scientific excellence *per se* of the cited work in question?

Inevitably, this leads to the discussion of the few anomalies I've mentioned in the past. Clearly, the explicit citation of a particular method widely used in certain fields may be out of proportion to the *intellectual* significance of the method itself. Nevertheless, I have repeatedly reminded readers that, apart from the rare exception—only 317 papers have been cited over 1,000 times from 1961 through 1980, although it should be kept in mind that the more recent papers have had less chance to acquire citations than the earlier papers—the effect of a single paper is not generally sufficient to catapult most scientists into eminence. There is a combination of publication and citation frequency that seems to be the pattern for persons *of Nobel class*. We discovered this point about 20 years ago.[7] However, we have not as yet analyzed in sufficient detail what that pattern is for a large population of scientists. Some would argue that the number of papers one publishes is as good an indicator of excellence as citation frequency.

Since our studies emphasize the most-cited scientists in the absolute sense, we must be aware that this limits our horizon to scientists working in "larger" areas of research. The most-cited scientists working in the area of "theoretical" biology, for example, are apt to be cited less frequently than the most-cited scientists working in, say, molecular biology. This is *not* because the chances for being cited are different.[8,9] Rather, in a large population, a few people in the upper percentiles will simply receive absolute counts that are higher than everyone else's. In other words, if a field has produced only 100 papers, then even if everyone in that field cites the pioneers, the maximum number of references any one author can receive will be 100. In a field with 1,000 papers, the most-cited author could conceivably receive 1,000 references.

This is, of course, a gross simplification. It is not so much the absolute number of papers in a field that is important. Rather, it is the rate of publication of papers that matters.[10] Moreover, there can be no absolute partitioning of scientific papers and fields. The best papers in a "small" field may in fact be picked up by papers outside that field. Thus, while there may be very few people working in, say, the philosophy of science, the citation of works on that subject may be enormous—as is the case with the work of T.S. Kuhn[11] and K.R. Popper.[12] Characteristically, work in small fields may *initially* appear to be cited only by a

small group of peers. Later on, however, the significant work receives attention from a wide spectrum of fields. And it should be noted that citation frequency varies enormously from field to field. It seems to depend on the following factors: the rate of publication in that field; the convention of how many references per paper there are in the field—high in biochemistry, for instance, while low in mathematics; and the balance between methods papers and cognitive papers.[10]

In a recent essay, I discussed certain non-Nobel prizes awarded by various organizations located here in Philadelphia.[13] Table 1 presents a sampling of 52 other national and international non-Nobels. Arranged *alphabetically*, the table includes information on the field(s) each prize honors, its most recent cash value, the frequency with which the award is made, and the year the award was established. The table is far from exhaustive. The number of scientific awards is so great that many are unknown even to scientists working in the fields they are intended to honor.[14] (p. 46-81) The table was kept to a manageable size by limiting the list to those prizes worth at least $15,000 as an arbitrary threshold. Even so, it is possible that some prizes even at this threshold have been omitted. We have made a fairly exhaustive search, however.

Nevertheless, the table indicates certain interesting characteristics of awards. For instance, older awards—such as the Paul Ehrlich-Ludwig-Darmstaedter Preis, established in 1929 to honor achievement in medicine and biosciences—tend to be rather broad in scope. They consider candidates from whole disciplines, whereas such recently established awards as the Ciba-Geigy Ilar Rheumatism Prize founded in 1969, limit their considerations to a few, closely related specialties.

Awards serve several purposes. Among the most obvious and important functions they perform is to identify and honor scientific excellence. Jonathan Cole, Columbia University, and Stephen Cole, State University of New York, define "scientific excellence" as work currently thought useful by one's colleagues.[14] (p. 24) Thus, awards presumably encourage the working scientist to focus on important problems whose solutions are likely to bring recognition.

Awards also affect scholarly communication.[14] Since only those ideas and discoveries which become known to the scientific community at large can have any impact on the course of science, awards heighten the visibility—and, thus, the usefulness—of important discoveries. How well an award rewards and encourages excellence depends to a large extent on the amount of prestige it is accorded. Obviously, well-known, prestigious awards focus attention more effectively upon a scientist and his or her discovery than do obscure prizes. But an award's prestige defies quantification. It is subject to irrational, often unconscious judgments. According to Harriet Zuckerman, Columbia University, there are three major factors known to influence the perception of an award's prestige: the age of a prize; the amount of its honorarium; and the stature of its awarding, or sponsoring, body.[5] (p. 20) Nevertheless, no direct relationship exists between prestige and any or all of these characteristics.

For example, knowing the age of an award does not in itself suffice to determine that award's prestige. According to Zuckerman, the Copley and Rumford Medals, established by the Royal Society of London in 1731 to honor outstanding philosophical research and in 1800 for discoveries concerning heat or light, respectively, have acquired a certain patina of respectability from their ancient and distinguished lineage, as well as from their list of distinguished winners.[5] Yet certain recently established awards—such as the Albert Lasker Awards, founded in 1944 and first given through the American Public Health Association in 1946, and the Albert Lasker

Table 1: Non-Nobel awards with honoraria of $15,000 or more, arranged alphabetically with the sponsor(s), field(s) each honors, most recent cash value, frequency of the award, and the year the award was established. N.A. indicates information not available.

American Business Cancer Research Foundation Award, Southport, CT; for cancer research; an honorarium of $600,000. Given irregularly. Started: 1978.

Bristol-Myers Award for Distinguished Achievement in Cancer Research, Bristol-Myers Company, New York, NY; for cancer research; 2 awards of $25,000 each. Given annually. Started: 1977.

Bristol-Myers Award for Distinguished Achievement in Nutrition Research, Bristol-Myers Company, New York, NY; for nutrition research; an honorarium of $50,000. Given annually. Started: 1981.

Brookdale Awards for Research in Gerontology, Gerontological Society of America, Washington, DC; for gerontology; an honorarium of $20,000. Given annually. Started: 1979.

Ciba-Geigy Ilar Rheumatism Prize, International League Against Rheumatism, Basel, Switzerland; for rheumatism; an honorarium of 50,000 Swiss francs (approx. $26,000). Given quadrennially. Started: 1969.

Arthur C. Cope Award, American Chemical Society, Washington, DC; for organic chemistry; an honorarium of $10,000 to researcher and $10,000 for research. Given biennially. Started: 1972.

Holger Crafoord Prizes, Royal Swedish Academy of Sciences, Stockholm, Sweden; for mathematics or astronomy or bioscience or geoscience; an honorarium of $135,000 to one of the four candidate fields.[1] Given annually. Started: 1981.

Paul Ehrlich-Ludwig-Darmstaedter Preis, Paul Ehrlich-Stiftung, Frankfurt am Main, FRG; for medicine, biosciences; an honorarium of 50,000 DM (approx. $21,005). Given annually. Started: 1929.

FASEB Award for Research in the Life Sciences, Federation of American Societies for Experimental Biology, Bethesda, MD; for life sciences; an honorarium of $5,000 to awardee, $10,000 to parent institution. Given annually. Started: 1976.

Antonio Feltrinelli Prizes, Feltrinelli Foundation, National Academy of Sciences, Rome, Italy; for moral and historical sciences, or natural and physical sciences and mathematics, or medicine, or literature, or the arts; an honorarium of 100 million lire (approx. $83,000).[2] Given annually. Started: 1942.

Enrico Fermi Memorial Award, United States Department of Energy, Washington, DC; for atomic energy; an honorarium of $25,000. Given not more than once a year. Started: 1956.

Fujihara Prize, Fujihara Foundation of Science, Tokyo, Japan; for science, technology, mathematics, medicine; an honorarium of 2 prizes of 10 million yen each (approx. $40,000 each).[2] Given annually. Started: 1959.

Gairdner Foundation Award of Merit, Gairdner Foundation, Willowdale, Canada; for medicine; an honorarium of $25,000. Given irregularly. Started: 1957.

Armand Hammer Cancer Prize, Armand Hammer Foundation, Los Angeles, CA; for cancer research; an honorarium of $100,000, or $1,000,000 to be awarded when cure is discovered. Given annually. Started: 1981.

The Harvey Prize, American Society for Technion, New York, NY; for science, technology, health, Middle East peace; an honorarium of $35,000. Given annually. Started: 1973.

Lita Annenberg Hazen Award for Excellence in Clinical Research, Mount Sinai School of Medicine, New York, NY; for clinical research; an honorarium of $100,000. Given annually. Started: 1979.

Dr. H.P. Heineken Prize, Heineken Foundation, Royal Netherlands Academy of Arts & Sciences, Amsterdam, the Netherlands; for biochemistry, biophysics; an honorarium of 100,000 Dutch florins (approx. $37,000). Given triennially. Started: 1963.

Louisa Gross Horwitz Prize, Columbia University, College of Physicians and Surgeons, New York, NY; for biology, biochemistry; an honorarium of $25,000. Given annually. Started: 1967.

Bernardo A. Houssay Science Prize, Organization of American States (OAS), Washington, DC; for science, technology related to development; an honorarium of $30,000. Given annually. Started: 1972.

Humboldt Prize for Senior U.S. Scientists, Alexander von Humboldt-Stiftung, Bonn, FRG; for scientific cooperation between U.S. and Germany; an honorarium of 25,000 DM-72,000 DM (approx. $10,500-$30,230). Given annually. Started: 1972.

Anders Jahres Prize in Medicine, Oslo University, Oslo, Norway; for medicine; honoraria of first prize: 200,000 crowns (approx. $34,000); second prize: 100,000 crowns (approx. $17,000). Given annually. Started: 1953.

KFAS Prizes, Kuwait Foundation for the Advancement of Sciences, Safat, Kuwait; for science, mathematics; an honorarium of 10,000 Kuwait dollars (approx. $36,000). Given annually. Started: N.A.

Charles F. Kettering Prize, General Motors Cancer Research Foundation, Detroit, MI; for cancer research; an honorarium of $100,000. Given annually. Started: 1978.

King Faisal International Prize for Medicine, King Faisal International Prize, Riyadh, Saudi Arabia; for medicine; an honorarium of 250,000 Saudi rayals (approx. $75,000). Given: Annually. Started: 1980.

King Faisal International Prize for Science, King Faisal International Prize, Riyadh, Saudi Arabia; for science; an honorarium of 250,000 Saudi rayals (approx. $75,000). Given: Annually. Started: 1982.

Albert Lasker Medical Awards:
Albert Lasker Basic Medical Research Award, Albert and Mary Lasker Foundation, New York, NY; for medicine; an honorarium of $15,000. Given annually. Started: 1946.
Albert Lasker Clinical Medical Research Award, Albert and Mary Lasker Foundation, New York, NY; for clinical medical research; an honorarium of $15,000. Given annually. Started: 1946.

Richard Lounsberry Prize, National Academy of Sciences, Washington, DC; for medicine, biology; an honorarium of $50,000. Given annually. Started: 1978.

MacArthur Prize Fellow Award, John D. and Catherine T. MacArthur Foundation, Chicago, IL; for all disciplines; an honorarium of $24,000-$60,000/yr for 5 years depending on age. Given annually. Started: 1978.

MacArthur Prize Fellow Laureate Award, John D. and Catherine T. MacArthur Foundation, Chicago, IL; for all disciplines; an honorarium of $60,000 annually for life. Given annually. Started: 1981.

MacRobert Award, Council of Engineering Institutions, London, UK; for engineering, physical sciences; an honorarium of £25,000 (approx. $44,847). Given annually. Started: 1968.

Guglielmo Marconi International Fellowship, Aspen Institute for Humanistic Studies, Boulder, CO; for science or technology applied to humanist goals; an honorarium of $25,000. Given annually. Started: 1974.

Charles S. Mott Prize, General Motors Cancer Research Foundation, Detroit, MI; for cancer research; an honorarium of $100,000. Given annually. Started: 1978.

NAS Award for Initiatives in Research, established by Bell Telephone Laboratories in honor of William O. Baker, National Academy of Sciences, Washington, DC; for new scientists; an honorarium of $15,000. Given annually. Started: 1980.

Otto Naegeli-Preis, Otto Naegeli-Stiftung, Zurich, Switzerland; for medicine; an honorarium of 100,000 Swiss francs (approx. $47,500). Given annually. Started: N.A.

Premio Nacional de Ciencias, Ministerio de Educacion Nacional, Bogota, Colombia; for science; an honorarium of $100,000. Given annually. Started: 1964.

Prix Ampère de l'Électricité de France, Académie des Sciences, Paris, France; for mathematics, physics; an honorarium of 200,000 francs (approx. $32,000). Given annually. Started: 1975.

Prix Charles-Léopold-Mayer, Charles-Léopold-Mayer Fondation, Académie des Sciences, Paris, France; for biosciences; an honorarium of 220,000 francs (approx. $35,000). Given annually. Started: N.A.

Prix Claude-Adolphe Nativelle de Médecine, Fondation Claude-Adolphe Nativelle, Pour l'Art et la Médecine, Paris, France; for cardiovascular diseases, French language, and science; an honorarium of 500,000 francs (approx. $80,000). Given triennially. Started 1972.

Prix Docteur A. De Leeuw-Damry-Bourlart & Prijs Doctor A. De Leeuw-Damry-Bourlart, Fonds National de la Recherche Scientifique, Brussels, Belgium; for mathematics, physics, chemistry, 2 prizes each for French speakers and Dutch speakers; honoraria of 4 prizes of 1,250,000 Belgian francs each (approx. $25,000 each).[2] Given quinquennially. Started: 1929.

Prix de la Fondation Professeur Lucien Dautrebande, Fondation Professeur Lucien Dautrebande, Huy, Belgium; for physiopathology; an honorarium of 900,000 Belgian francs (approx. $18,900). Given triennially. Started: 1959.

Prix Francqui, Fondation Francqui, Brussels, Belgium; for human sciences or chemistry, physics, and mathematics, or natural sciences and medicine; an honorarium of 1,000,000 Belgian francs (approx. $22,000) to one of the three candidate fields.[2] Given annually. Started: 1932.

Prix Marie-Victorin, Ministère des Affaires Culturelles, Quebec, Canada; for pure sciences; an honorarium of $15,000. Given annually. Started: 1967.

Prix Scientifique Joseph Maisin & Wetenschappelijke Prijs Joseph Maisin, Fonds de la Recherche Scientifique Medicale, Brussels, Belgium; for natural and medical sciences, 2 prizes each for French speakers and Dutch speakers; honoraria of 4 prizes of 1,250,000 Belgian francs each (approx. $25,000 each).[2] Given quinquennially. Started: N.A.

RPB Jules Stein Award for Outstanding Ophthalmic Achievement, Research to Prevent Blindness, Inc., New York, NY; for blindness research; an honorarium of $25,000. Given irregularly. Started: 1966.

Alfred P. Sloan Prize, General Motors Cancer Research Foundation, Detroit, MI; for cancer research; an honorarium of $100,000. Given annually. Started: 1979.

Texas Instruments Foundation Founders' Prize, Texas Instruments Foundation, Dallas, TX; for health sciences, physical sciences, engineering, mathematics, management sciences; an honorarium of $35,000. Given annually. Started: 1974.

John and Alice Tyler Ecology-Energy Prize, John and Alice Tyler Ecology-Energy Fund, University of Southern California, Los Angeles, CA; for environment, energy; an honorarium of $150,000-$200,000. Given annually. Started: 1973.

Vetlesen Prize, G. Unger Vetlesen Foundation, New York, NY; for earth sciences; an honorarium of $50,000. Given biennially. Started: 1959.

Alan T. Waterman Award, Alan T. Waterman Award Committee, National Science Foundation, Washington, DC; for physical sciences, engineering, mathematics, social sciences, biological sciences; an honorarium of $50,000. Given annually. Started: 1975.

Welch Award in Chemistry, Robert A. Welch Foundation, Houston, TX; for scientific betterment of humanity; an honorarium of $150,000. Given annually. Started: 1954.

Wolf Prizes, Wolf Foundation, Herzliah-Bet, Israel; for physics, mathematics, agriculture, medicine, chemistry; an honorarium of $100,000 awarded in each of the five eligible categories. Given annually. Started: 1976.

Wright Prize, Harvey Mudd College, Claremont, CA; for science; an honorarium of $20,000. Given annually. Started: 1980.

[1] Field in which award is presented rotates each year. Half of the prize money goes to award-winner, while other half goes to support Swedish research in the award-winning field.

[2] Awards are made each year in any of the eligible fields.

Medical Research Awards in basic and clinical research, founded in 1962 by the Albert and Mary Lasker Foundation—have achieved a considerable degree of prestige as well.[15] Perhaps what these newer awards lack in antiquity they make up for in terms of the perception that they recognize state of the art research or problems of great universal concern.

In the unspoken competition for status among scientific honors, Zuckerman writes, a characteristic that is associated with the prestige of an award is the age and prestige of the body sponsoring the award.[5] The prestige of the French Académie des Sciences, for instance, is conferred on the Prix Charles-Léopold-Mayer, which recognizes outstanding achievement in the biosciences. The US National Academy of Sciences (NAS) lends distinction to the Award for Initiatives in Research, which recognizes the achievements of new scientists. And the Appleton Prize, which rewards distinguished contributions in ionospheric physics, benefits from the venerability of the Royal Society. Incidentally, none of the awards sponsored by the Royal Society appear in Table 1, since none achieved the $15,000 minimum thres-

hold. Prizes sponsored by the business community, no matter how much they are appreciated by the recipients and the scientific community, are a form of public relations. In my opinion, however, this may not detract from their prestige, as long as the selection procedure is not subject to commercial considerations.

In a curiously circular relationship, the prestige of an award may be buttressed not only by the reputation of its sponsor, but also by the stature of its recipients, if the list is sufficiently long and distinguished.[5] For example, the Rumford Medal no doubt derives much of its status from its impressive catalog of recipients: Albert A. Michelson (1888), Thomas A. Edison (1895), Frederic E. Ives (1912), Harlow Shapley (1933), William W. Coblentz (1937), Edwin H. Land (1945), Enrico Fermi (1953), Subrahmanyan Chandrasekhar (1957), and Hans A. Bethe (1963), to name a few. Prizes in science can even gain prestige by having established a reputation for recognizing outstanding scientists *before* the sponsoring body of some rival prize gets around to doing so.[5,16] This is probably true of the Lasker and Franklin Awards. Incidentally, the American Chemical Society's Award in Pure Chemistry for outstanding fundamental research in chemistry is often overlooked, due perhaps to the relatively modest size of its honorarium ($2,000) and the fact that it is awarded to relatively young scientists (under 36 years of age). Yet it has been won by such scholars as Linus Pauling, Glenn Seaborg, Carl Djerassi, and Roald Hoffmann.

Still another major factor contributing to the prestige of a given prize is the amount of its honorarium. A direct relationship between prestige and wealth is a natural enough assumption. And, in fact, numerous examples of highly remunerative, highly prestigious awards do exist: the Welch Award in Chemistry, sponsored annually by the Robert A. Welch Foundation, Houston, Texas, worth $150,000; the John and Alice Tyler Ecology-Energy Prize, administered by the University of Southern California, Los Angeles, with an honorarium varying from $150,000 to $200,000 annually; and the Wolf Prizes in physics, mathematics, agriculture, medicine, and chemistry, sponsored by the Wolf Foundation in Israel, worth $100,000 each to their respective recipients. But when one considers that the Fields Medal for outstanding achievement in mathematics consists of a gold medal and a "mere" $1,300 honorarium, and that the American Chemical Society's Priestley Medal for distinguished service to chemistry consists of "only" a gold medal, one quickly realizes that high cash value is not an exclusive ingredient for prestige. An interesting example of such an award is the William Procter Prize, established in 1950 by Sigma Xi, the scientific research society, in recognition of outstanding or notable accomplishments in research or in the administration of research. It was recently bestowed on Nobel prizewinner Joshua Lederberg. Even Nobelists like to be remembered for their other accomplishments.

There are other factors by which the prestige of an award is commonly, and perhaps unconsciously, reckoned. One is the degree to which a particular prize is perceived as honoring scientific excellence wherever it is found, regardless of the prospective recipient's political and religious beliefs, race, and country of origin or residence. One wonders if such Belgian awards as the Prix Scientifique Joseph Maisin, the Prix Docteur A. De Leeuw-Damry-Bourlart, and the Prix Scientifique Ernest-John Solvay would be more prestigious if they weren't restricted to research published in French. And one could name certain awards that are motivated by political viewpoint as well as scientific accomplishment.

Also affecting prestige is the interval of time between each presentation of an

award. If awarded too often—and there is no precise definition of "too often"—it may become "trivial" because of its frequency. It is instructive that none of the prizes listed in Table 1 is awarded more frequently than annually. However, if an award is not presented often enough, it may be forgotten between each occasion on which it is presented. The Belgian awards I mentioned earlier are given once every five years, which may have a negative effect on their visibility.

Closely related to frequency is the number of recipients. If nearly everyone receives a particular prize, it becomes so common that its value is diminished. Conversely, limiting the recipients to a highly select elite ensures that the award will remain a precious commodity. Finally, as Zuckerman notes, the scope of the prize—that is, whether it is given locally or is restricted to a relatively obscure discipline, or if it is given in an international and established field—greatly affects the prize's visibility and prestige.[5] In other words, was the recipient a big fish in a big pond?

In their study of stratification among physicists, the Coles found, reassuringly, that the quality of a physicist's work had a far stronger influence on the number of awards he or she could expect to receive than did the sheer number of papers produced.[14] (p. 93) Mere bulk of output was of virtually no use in predicting the number of prizes a scientist possessed. Moreover, high-quality work was rewarded without regard for the place in which a scientist was trained or the facility where the research had been conducted. The Coles also found a direct relationship between prestige and the number of awards a scientist possessed, as well as the number of citations his or her work had received.

However, the Coles also found that the prestige of the institution with which a physicist is currently affiliated had some influence on that individual's visibility, and thus probably some effect on the amount of recognition that individual later received.[14] (p. 95) Physicists also tended to evaluate work more favorably if the author was affiliated with a prestigious institution; the greater the rank of the institution, the higher was the evaluation. Indeed, simply working in a "hot" field can enhance prestige.[14] Thus, the probability that one will receive an award appears to depend at least in part on the quality of one's work—as it should—and in part on unpredictable subjective factors such as the Matthew effect, in which those awards, institutions, and individuals labeled as prestigious accrue even more prestige simply by virtue of the label.[17]

Complicating matters still further, however—as even a casual glance at Table 1 will show—is the recent explosion in the sheer volume of awards for scientific achievement. The increase shown by the table is in part due to the table's inherent bias: limiting the list to those prizes worth $15,000 or more effectively eliminated most of the older awards (which is itself significant, indicating that newer awards tend to have higher cash values than older ones). Nevertheless, the table reveals a certain futility associated with the newer prizes. Over and over again, prizes are established to honor research in the same field. For instance, the table lists six awards restricted to honoring achievement in the field of "cancer research": the American Business Cancer Research Foundation Award, the Bristol-Meyers Award for Distinguished Achievement in Cancer Research, the Armand Hammer Cancer Prize, and those awarded by the General Motors Cancer Research Foundation—the Charles F. Kettering Prize, the Charles S. Mott Prize, and the Alfred P. Sloan Prize. But when one considers the number of awards presented each year in biosciences, life sciences, medicine, clinical research, biochemistry, biology, physiopathology, and those open to all disciplines or honoring science in general, the number of additional awards that could conceiv-

ably be given for "cancer research" rapidly becomes incalculable. Even for as worthy a cause as cancer research, one must question whether establishing a multiplicity of awards serves the intended purpose of honoring excellence or the wholly unintentional one of debasing it. But one must not forget that the purpose of many of these awards is to help gain public support for continued research.

All this is not to argue for an end to the creation of new awards. In fact, ISI® sponsors awards in areas that previously were not recognized, as, for example, the NAS Award for Excellence in Scientific Reviewing,[18] and the Bernal Prize of the Society for Social Studies of Science.[19] The dilemma of cancer research is that there are so many facets to the problem that no single award could do justice to the many different problems, both basic and applied, that need solution. When an award is presented to a basic research scientist for discoveries that may lead to a better understanding of cancer, does it serve society's interest best if cancer, rather than the basic field, is singled out for recognition? Perhaps the public is more approachable on the concrete grounds of cancer, rheumatism, arthritis, or depression than on the basis of basic research.

A thorny problem facing both those who award prizes and those who receive them is that of equitably determining who deserves a given prize. More and more discoveries are achieved in collaborative efforts. For instance, the Lasker award in basic medical research this year was shared by five individuals while two scientists shared the Lasker award in clinical medical research.[20] Moreover, as I pointed out in a previous essay, awards committees more frequently face the problem of simultaneous independent discoveries.[21]

To my knowledge, there has been no study to determine whether awards, Nobel or otherwise, have the effects their creators imagined. There is anecdotal evidence that the quest for the Nobel prize has "driven" scientists to feverish activity day and night to make important discoveries first. But there is also ample evidence that even without such recognition, scientists in the past would have strived to be first regardless of the pot of gold at the end of the rainbow.[22]

In every other walk of life, "bonuses" of one kind or another are supposed to be positive inducements to human productivity. The very existence of many handsome and prestigious awards, no less than a Hollywood Oscar, creates a climate in which the productivity of scientists is somehow improved. While most accomplished scientists continue to work in their laboratories, regardless of the financial support they receive, it is absurd to believe that they can operate at maximum efficiency under conditions such as experienced by the Curies, or others in the more romanticized chapters of history.

It may well be that the awards system is one of the finest products of the democratic meritocracy. As long as the selection procedures are thorough, and as long as we properly recognize as quickly as possible new and emerging territories on the map of science, then we should welcome the diversity of awards we have identified.

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