Creativity versus age

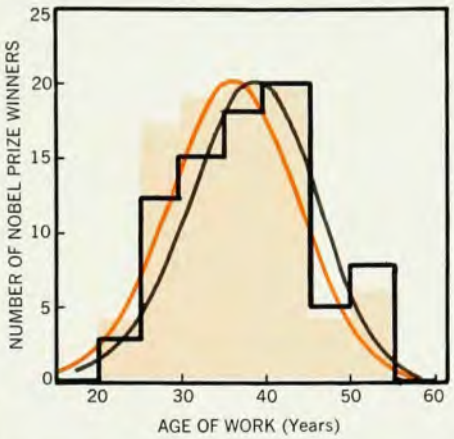
In the October issue (page 9) A. J. Owens has given an interesting analysis of the consequences that changes in population growth may have on overall scientific creativity of the population, using the distribution of ages of Nobel Prize-winning work in physics $N(A)$ as a starting point.

$N(A)$ is related to the average creativity *per capita* as a function of age, a quantity that is of interest to the management of scientific institutes, since it has a bearing on the personnel policy. D. C. Pelz and F. M. Andrews[1] have given experimental data on scientific performance as a function of age. It is remarkable that both their curves and Owens's figure 1 show a dip around 45–50 years. A similar (though less pronounced) dip was observed in curves showing the average measurable output *per capita* (manuscripts + reports + inventions) in our laboratories.

In my opinion this dip is mainly due to the fact that in the age group between 45 and 50 a large fraction of the scientists has been given an increased organizational responsibility. In these years the new type of work takes quite some creative energy, the output of which is difficult to measure and is thus not completely incorporated in the statistics. In general, this output helps in increasing the output of younger scientists. In any case, this dip was absent for a sample of a dozen scientists from our lab whose output could be traced from about age 25 until their retirement, and who, during their career, had never been charged with major organizational responsibilities.

Owens fits the age distribution in his figure 1 to a Gaussian curve with a mean age of 36.2 years and a standard deviation of 7–6 years, remarking that its most striking feature is the "old" age of 36 about which the distribution is centered. However to draw, from the age distribution given, conclusions with respect to the creativity *per capita*, the curve should first be corrected for the age distribution of the population concerned. I have done this, using from Owens's figure 2 the curve relating to 1.5% growth. The result is given in the diagram.

One may question whether creativity as a function of age should, indeed, fit a Gaussian. However, a Gaussian fitted to my diagram has an even older mean age (39 years) and a larger standard deviation (8.5 years) than Owens's Gaussian. This, added to Owens's indication of a progression of "older" creative work as the research becomes more applied, may be a warning to the management of research institutes that it is perhaps "in the nature of things that it is the older physicist who must pay the price." [2]



Corrected distribution of ages of Nobel Prize winners in physics (black curve) has mean of 39 years compared to 36 years for curve (colored) originally published.

References

1. D. C. Pelz, F. M. Andrews, *Scientists in Organizations*, Wiley, New York, (1966), page 192.
2. G. Rohringer, PHYSICS TODAY, October 1973, page 11.

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In his interesting letter (October, page 9), A. J. Owens gave 36 years as the average age at which the Nobel prize-winning work was done.

In addition to prize winners themselves, there are often "big brothers" involved also. These unsung heroes (sometimes previous prize winners) are sometimes overlooked. The kind encouragement and understanding of patent-office supervisor Besso eased Einstein's task considerably. Without Einstein's favorable comments, Louis de Broglie's thesis, of eight typewritten pages with one simple equation $\lambda = h/p$, may have run into difficulties. Again without Einstein, the work of Bose, then an obscure physicist far away from Europe, would probably have received little attention. Without Peter Kapitza's intervention, Lev Landau would probably have died very young in Stalin's prison. Sir Lawrence Bragg's foresight, encouragement and long-term commitment over thirty years were important factors in the structural determinations of hemoglobin and myoglobin by John Kendrew and Max Perutz, and also in the double helix work of James Watson and Francis Crick. I might also mention Ernest Rutherford in the work of Niels Bohr (and also Henry Moseley, had he survived the First World War) and also the encouragement of Bohr given to his younger colleagues at Copenhagen over many years.

In the absence of big brothers, the researches of J. Willard Gibbs, Gregor Mendel, Einstein and others may have remained obscure for many years, to the detriment of science.

I suspect that the age distributions of big brothers would be considerably older than 36 ± 8.

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Pay your page charges

A statistical analysis of physics publications can yield very interesting and sometimes useful results. This was shown by the pioneer work of M. M. Kessler at MIT. The existence of the Citation Index and its by-products has greatly expanded the possibilities of such investigations. An excellent example is the recent article by Herbert Inhaber in May (page 39).

It is always encouraging to see the high rank attained by the journals of the American Physical Society in such studies. Inhaber mentions the high prestige of our journals, but rightly does not express a value judgment. However, the readers might be tempted to conclude that high rank is equivalent to superior quality of contents. Therefore, I wish to warn against this common misinterpretation of the data. I do not believe that the quality of papers in *Physical Review Letters* can be much above that of the European sister

letters

journal *Physics Letters*. Then, why are they so far apart in rank? The relatively low subscription price made possible by collecting page charges gives our journals an advantage by having a wider circulation. This, in my opinion, is the principal reason why they are quoted more often. The lesson to learn is that authors who want to be cited should see to it that their institutions honor page charges.

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Candidate for Congress

Compared to the number of lawyers in Congress, the number of scientists in this body is very small. So, it is good news to learn that Lloyd Allan Wood is now running for Democratic candidate for US Representative from the Sixth Congressional District of Ohio. As he was formerly in charge of Physical Sciences at the Air Force Office of Scientific Research, he is extremely well aware of problems and activities in this field. Let us hope Lloyd will get all the help possible.

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Competitive running

"A Theory of Competitive Running" by Joseph Keller (September, page 42) is an amusing article, but shows little familiarity with competitive running itself. In this regard he is given away by his choice of references for running records.

The constant D_c, the longest race that can be run at maximum acceleration, is not a new concept in Keller's theory. Those with experience in competitive track put the distance somewhere between 100 and 200 meters, depending on the individual. This is about half of Keller's value. Some runners, such as Herb Washington, even seem to have an optimal sprinting distance of less than 100 meters.

Keller's theory certainly does not "determine the optimal race strategy." He clearly ignores one of the most important effects, the presence of the other runners! The importance of other runners is demonstrated by the frequent use of a "hare" in a record attempt. The "hare," another good runner, will set a fast pace for the early part of the race. Then, the runner making the record attempt will take over. The "hare" often does not even complete the race.

A slower runner who can sprint can often beat a faster runner who can't. The slower runner follows the faster for most of the race, then spurts past him at the end. This is why Ron Clarke never won the big races, although he set world records from two miles to 10 000 meters. For an even-paced runner to beat a sprinter, he must have a sufficient margin of superiority that his competitors cannot keep up with him. Such great runners are rare, although in the early 1950's Emil Zatopek showed this superiority in the 10 000-meter run.

The suggestion that the last bit of the race be run while decelerating is not realistic, as the condition where $E(t) = 0$ is not well defined. A runner can often dig a little deeper to finish his race with an extra spurt. He draws on resources that he could not have employed for the entire race. A case in point is Tom Courtney's victory in the 800 meters in the 1956 Olympic Games. He so exerted himself at the end that it was not known if he was aware he had won.

The condition where it is clear that $E(t) = 0$ is familiar to most observers of track. A race is lost when the leader collapses within a few yards of the finish line. Another situation where obviously $E(t) = 0$ is found in the description of the 1948 Olympic Marathon in the official report of the British Olympic Association. I quote only a portion:

> "Gailly was first man back on the red track in the Wembley Stadium, but under the cruel strain of that spurt over the 25th and 26th miles with only one aim in mind ('I must be first at the Stadium!') he forgot all about the lap which had still to be run at the Stadium itself. He arrived 'all in,' and to this day neither Gailly himself nor anyone who watched him knows how, with waxen face and the tottering shuffle of utter exhaustion, he managed to finish those few hundred metres with a body that had practically ceased to function consciously. Only after crossing the finishing line third did Gailly's unflinching determination allow him to collapse, to be carried off on a stretcher."

For more in-depth information on competitive running, as well as more recent listings of world records, I would recommend the January, 1973 issue of *Track and Field News* or the latest edition of the *International Athletics Annual* published by World Sports.

Keller has obviously failed to appreciate the significance of individual differences even at the world-record level. No two greater milers have appeared in recent years than Jim Ryun and Filbert Bayi. Jim Ryun would sprint past his competitors on the final lap. Filbert Bayi attempts to "kill off" his opposition by running a first lap as fast as Ryun's last. Would they have done